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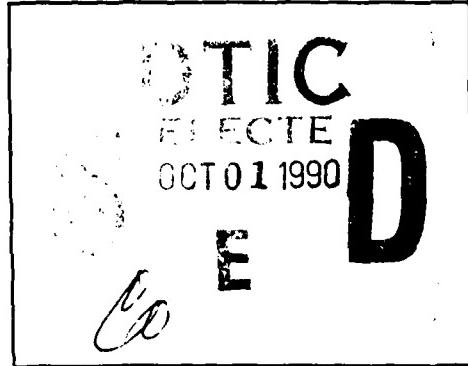
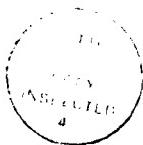
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**INSTALLATION RESTORATION PROGRAM
PHASE II —
CONFIRMATION/QUANTIFICATION
STAGE 1
FINAL REPORT
FOR
KINGSLEY FIELD, OREGON**

AD-A227 071

**TACTICAL AIR COMMAND
LANGLEY AFB, VIRGINIA**

PREPARED FOR:
United States Air Force
Occupational and Environmental Health Laboratory (OEHL)
Brooks Air Force Base, Texas 78235

June 15, 1985

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June 15, 1985

PREPARED BY:

Science Applications International Corporation
13400-B Northup Way, Suite 38
Bellevue, Washington 98005

Contract No. F33615-80-D-4002

Edward S. Barnes, Lt. Col., USAF, BSC
Technical Program Manager
Technical Services Division (TS)

PREPARED FOR:

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PREFACE

A field investigation was performed at Kingsley Field, Oregon to determine if environmental contamination has resulted from past waste disposal practices in a closed landfill. Site specific activities included an electrical resistivity study to determine the presence and directional flow of groundwater, installation of monitoring wells adjacent to the landfill, and seasonal sampling of groundwater from the two landfill monitoring wells and two domestic water supply wells on nearby off-base properties. Study findings suggest that landfill leachate may be mobilizing and migrating away from the landfill through groundwater transport. However, groundwater quality remains very good in both domestic wells tested and except for total iron, good in on-base monitoring wells. There are no contaminants yet detected in the groundwater which would threaten public or environmental health. A long-term monitoring program is recommended so as to detect changes in groundwater flow or quality.

Field investigations began in September 1983 and were completed in April 1984 with the conclusion of groundwater sampling. Dee Ann Sanders, Ph.D., and Major Edward S. Barnes were technical monitors for the USAF Occupational Environmental Health Laboratory. Ms. Lois F. Seibt and Mr. Walter Jones provided field logistics and escort assistance while conducting the field investigations. The authors also wish to express our appreciation to Michael L. Feves, Ph.D., of Foundation Sciences, Inc. who performed the electrical resistivity work and quite accurately established the depth to groundwater, and to Peter Dye for graphics work and Linda Wynands and Kim Spencer for project administration, report preparation and production.

Richard W. Greiling, P.E.

Robert L. Peshkin

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EXECUTIVE SUMMARY

This report presents the results of the Phase II confirmation investigations in accordance with the USAF Installation Restoration Program at Kingsley Field, Klamath Falls, Oregon. The investigations were performed to determine if environmental contamination has resulted from waste disposal practices at Kingsley Field; and to provide estimates of the magnitude and extent of contamination, should it be found. The IRP Phase I report identified Landfill No. 3 as the site with the greatest potential for contaminant release and migration and harmful impacts. Landfill No. 3 is located in the southeast corner of Kingsley Field and served as a disposal site for construction debris, industrial and maintenance wastes, limited quantities of pesticide and medical wastes, and large amounts of coal flyash between 1961 and 1979. The site has been covered and graded. The ground surface is generally flat with surface runoff and groundwater interception effected by a drainage ditch which is tied into the regional drainage system.

An electrical resistivity survey was performed to identify local groundwater surface relationships with the landfill and adjoining disturbed soils. The results of this survey were used to place two monitoring wells adjacent to and, during at least the seasonal irrigation period, hydraulically down-gradient of the landfill. Two off-base domestic water supply wells were also used for groundwater sampling and chemical characterization during both seasonally high and low groundwater periods.

The Phase II confirmation investigations suggest that seasonal flood irrigation practices on off-base properties cause shallow groundwaters to migrate onto the base. This groundwater flow is generally the reverse of the regional groundwater flow pattern in the Klamath Basin. Groundwater immediately adjacent to the landfill indicates the release of leachate from the landfill as measured by iron, chloride and carbonaceous oxygen demand (COD). However, water quality in the sampled domestic wells shows no evidence of groundwater contamination for the chemicals or compounds under scrutiny.

With one exception, no samples taken in the monitoring wells or water supply wells indicated the presence of chlorinated pesticides, volatile halocarbons or aromatics, or oil and grease. One water supply well sample taken in the pump house of a private residence indicated trace levels of methylene chloride and measurable concentrations of oil and grease, COD, and total organic carbon (TOC). These sample results may have been prejudiced by field contamination, however, because subsequent sampling from the water tap in the kitchen of the home reported no presence of any of the above compounds and a water quality consistent with or better than adjacent wells as measured by total iron, chloride and TOC concentrations. Neither of the homes used any in-line water filters or other water treatment devices.

It is our belief that while there is evidence that leachate from Landfill No. 3 is generated by groundwater flow through the active zone of the landfill, and that this leachate migrates to the aquifer beneath the fill, there are at present only limited dissolved organic materials and no measurable volatile organics, hydrocarbons or chlorinated pesticides in the near-surface groundwaters adjacent to the landfill. There appears to be no appreciable environmental degradation to the land surface or groundwater supplies. Finally, there are no public health or safety concerns based upon the extent of water sampling performed for this study.

We recommend that the USAF continue to take groundwater samples from at least the upper 40 feet of the aquifer in each of the two monitoring wells. One sample pair should be taken twice per year during periods of off-base flood irrigation and analyzed for total iron, chlorides, TOC and COD. These data will provide for early warning of release and migration of contaminants from the landfill. At least one additional sampling event should take place during periods of no off-base flood irrigation. These samples, when analyzed for the same parameters, will provide baseline chemical characteristics of the surface groundwater flow moving beneath the air base facilities from northwest to southeast. The monitoring wells may also serve as early warning of potential groundwater contamination problems whose origins may be associated with flight line, aircraft maintenance or fueling facilities located west of the main runway.

1.0 INTRODUCTION

1.1 THE INSTALLATION RESTORATION PROGRAM

Under the provisions of the Defense Environmental Quality Program Policy memorandum issued by the Department of Defense (DoD), a comprehensive Installation Restoration Program (IRP) is being implemented on DoD installations nationwide. The objective of the IRP program is to identify and evaluate past DoD hazardous disposal sites and to control the migration of hazardous environmental contamination resulting from such sites.

The IRP program is being performed in four phases. Phase I is the installation assessment (records search) intended to identify and rank those sites that may pose a hazard to the environment and public health. Phase II is the confirmation of the presence and extent of contamination, if found, at the highest ranked sites by a coherent field investigation. Phase III is the technical base development for preparing a comprehensive contaminant control plan (remedial action plan) and Phase IV is the implementation of the remedial measures.

The IRP Phase I records search for Kingsley Field, Oregon and two smaller off-site facilities was performed under contract by the consulting firm of CH2M-Hill. The Phase I records search was initiated in August, 1981 and the report was available for release in February, 1982. These activities included a detailed review of pertinent installation records, contacts with 14 local and regulatory agencies which were known or suspected to have documents containing relevant information, interviews with 15 former and present base personnel, and site visits to confirm reported waste disposal practices and locate these sites on base maps.

During the Phase I records search 14 sites of potential contamination were identified. Twelve of the sites are located at Kingsley Field and include one current and two former landfills, two inactive and two active miscellaneous solid waste burial sites, six liquid disposal or spill areas, and one crop duster washdown area that is partially on Kingsley Field property but is not controlled or managed by the Air Force. Four of the sites were ranked as

potential problem areas utilizing the USAF Hazardous Waste Ranking Methodology (HARM) developed initially for the U.S. Environmental Protection Agency (EPA) and modified to better address the needs of the Air Force. Of these four sites, Landfill No. 3 warranted further investigation. The Phase I report recommended that an IRP Phase II field investigation be performed at Landfill No. 3 to determine if there has been any release of contaminants into the soils or groundwaters beneath Kingsley Field.

Figure 1 is a representation of the major airfield facilities, the locations of the waste disposal sites identified in the IRP Phase I records search but which were not considered a threat to the public or the environment, and the location of Landfill No. 3 which was the subject of this investigation. Landfill No. 3 is located on joint use property south of Runway 25. The fill was used from 1961 through 1979 for the disposal of miscellaneous base wastes and is currently used for the occasional disposal of construction debris. It was reported to the IRP Phase I investigators that this landfill contained unrinsed pesticide containers; as much as one cubic yard of DDT; approximately 1-1/2 cubic yards of medical wastes; paint, thinner and solvent containers; and general refuse. It is unknown whether the DDT and medical wastes were disposed in the liquid or solid state. It is known, however, that the site has served as Kingsley Field's major coal flyash disposal site since 1960.

The USAF Occupational and Environmental Health Laboratory (OEHL) in June, 1983 retained JRB Associates to perform an Installation Restoration Program Phase II field investigation at Kingsley Field using funding provided by the United States Air Force. Field work commenced in September, 1983 in response to the recommendations of the IRP Phase I report, and included the construction of two shallow monitoring wells near the landfill, and the sampling of these wells plus two adjacent domestic water supply wells at both seasonal groundwater high and low periods. All water samples were then analyzed for COD, TOC, purgeable halocarbons and aromatic hydrocarbons, chlorinated pesticides, oil and grease, iron and chloride. The sum of the data collected would be interpreted to enable the USAF to develop a remedial response plan if necessary.

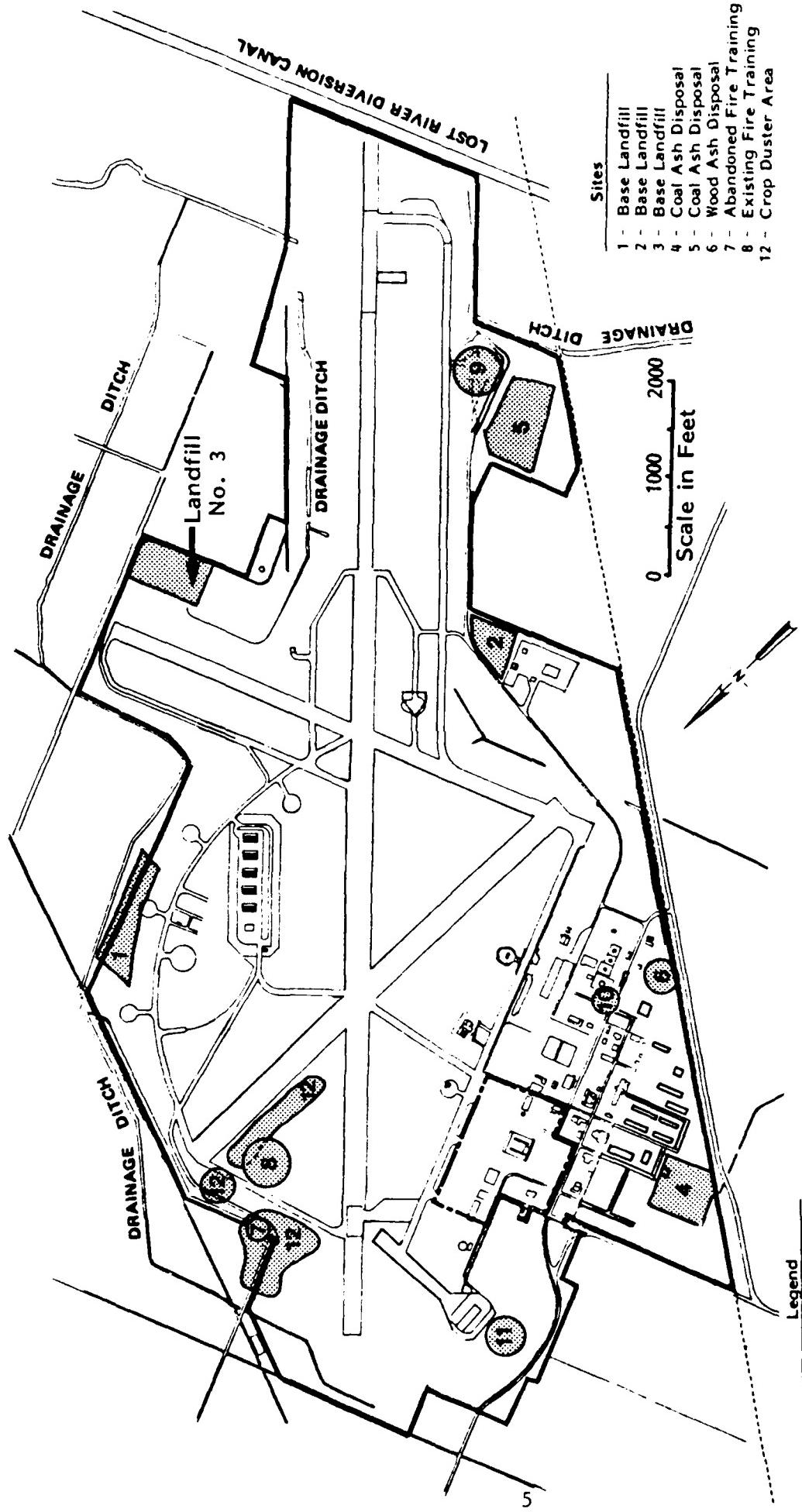


Figure 1

LOCATION MAP OF LANDFILL NO. 3 AND
OTHER IRP PHASE I SITES AT KINGSLY FIELD

1.2 BASE HISTORY/MISSION

Kingsley Field is located at an elevation of approximately 4,100 feet MSL, three miles southeast of the City of Klamath Falls. The airfield is 14 miles north of the California border in the Klamath Basin of south-central Oregon. Figure 2 is a regional location map of Kingsley Field and Klamath Falls. Kingsley Field was dedicated in 1957 as a joint use facility of the City of Klamath Falls and the U.S. Air Force for municipal and fighter-interceptor operations, respectively. Of the 1,100 acres occupied by Kingsley Field, 74 acres are owned by the United States Air Force and the remainder is owned by the City of Klamath Falls.

The basic mission of units stationed at Kingsley Field has always been to support the North American Air Defense (NORAD) and the Aerospace Defense Command. Prior to 1971, the mission was centered around active fighter interceptor squadrons to provide air defense for the Pacific Northwest. The aircraft control and warning unit at Keno Air Force Station became the host unit after the deactivation of the host fighter unit. In 1978, the Keno AFS radar facilities were deactivated. From 1978 to 1982, the Air Force maintained the Alert Commission Detachment for the 25th Air Division. In January 1982, the Oregon Air National Guard, 142nd Operating Location Detachment from the Portland International Airport, assumed the duties of maintaining the Alert Commission with all runway and taxiway maintenance, fire, crash, rescue and emergency medical support being provided by the Tactical Air Command through the Joint Use Services Agreement.

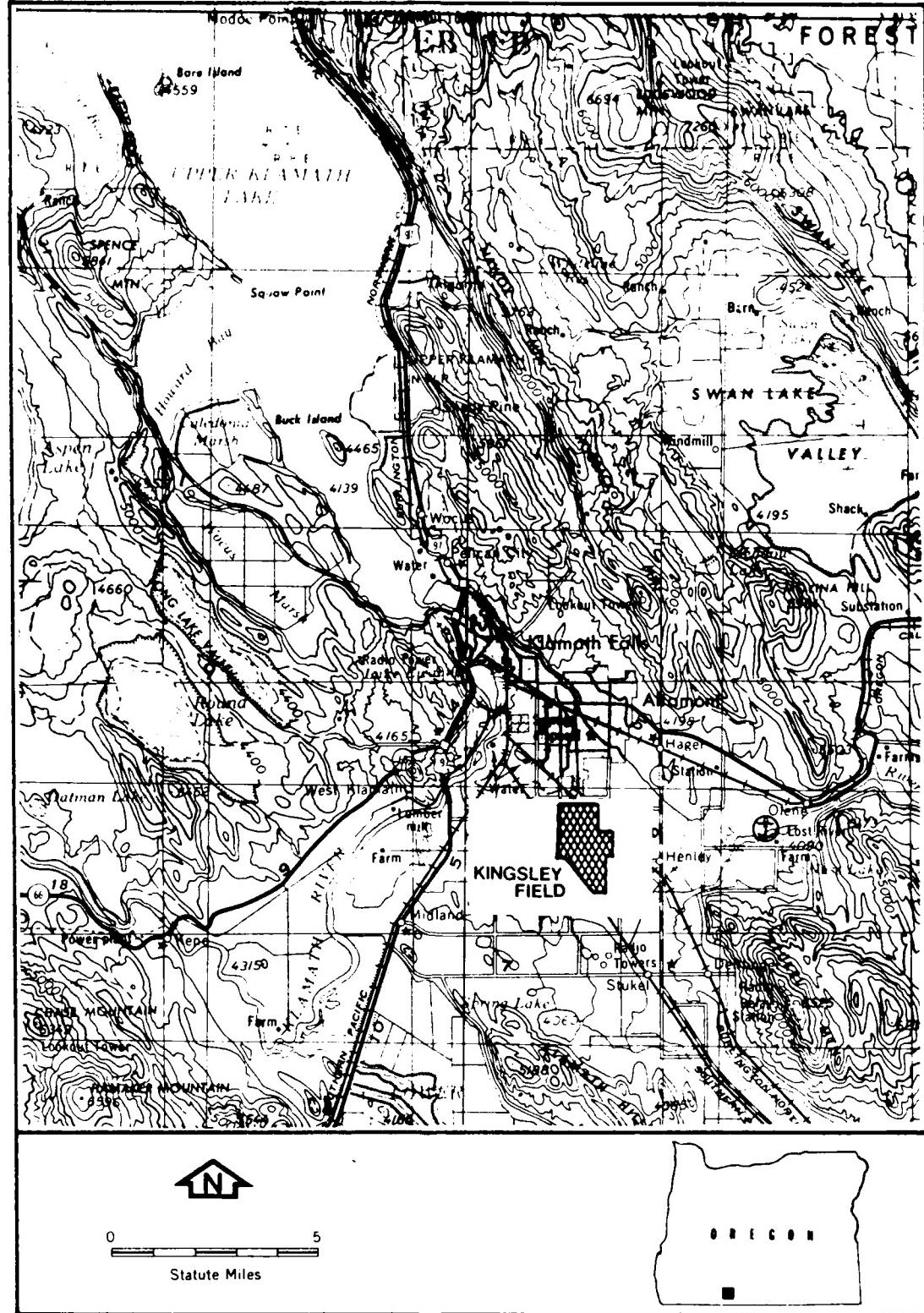


Figure 2

LOCATION MAP OF KINGSLEY FIELD AND
KLAMATH FALLS, OREGON

2.0 ENVIRONMENTAL SETTING

Kingsley Field is located on the dry Lower Klamath Lakebed in the semi-arid Klamath Basin of south-central Oregon. The Klamath Basin is underlain by block faulted graben (down-dropped crustal block) which is typical of the basin and range physiographic province. The basin is flanked by uplifted blocks bounded by steeply dipping (>60 degrees) normal faults which trend northwest/southeast. The volcanic activity and faulting that produced the present topography in the Kingsley Field area occurred mostly during the Pleistocene epoch of the past 2.5 million years. The Cascade Range borders the Klamath Basin on the west and the eastern boundary consists of the block faulted volcanic highlands of southeastern Oregon.

Kingsley Field lies at the northern end of the Lower Klamath Lakebed on a series of lacustrine sands, silts and clays which were carried into the basin by a complex network of surface drainages. The lake was probably the recipient of continuous sediment-laden floods during the cold and wet short summers of Pleistocene times. These sediments were the weathering products of the basalt, andesite, dacite, cinders, ash and pumice of which the surrounding mountains are composed. Combining the flat regional topography around Kingsley Field with the generally low to medium porosity, but low permeability and specific yield of nonindurated lacustrine sediments, the Lower Klamath Lakebed can be described to be a natural aquifer with limited productivity potential. This assumption is supported by studies which suggest that the shallow groundwater reservoir in the Lower Klamath Lake valley is for the most part a continuous, largely unconfined body to depths of more than 1,500 feet (Sammel, 1980). However, specific capacities of shallow wells in the Kingsley Field area are likely to be in the range of 0.01 to 1.0 gpm/ft of drawdown due to the abundance of fine grained sands, silt and clay, and only traces of the more permeable coarser sands and gravel. Generally, the shallow sedimentary beds yield quantities of water sufficient only for domestic purposes, while deep wells must be constructed in order to withdraw water for public, industrial or agricultural use. Even these wells are subject to large pumping declines and slow recovery rates.

Groundwater levels are high in the vicinity of Kingsley Field, ranging from two to ten feet below the ground surface (Sammel, 1980; CH2M-Hill, 1982). Under natural conditions the groundwater levels would probably be even higher. The U.S. Bureau of Reclamation's Klamath Project is a system of 700 miles of irrigation canals and ditches in the Klamath Basin which effectively control the groundwater level and provide water for irrigating 200,000 acres of land in Oregon and California. Regional groundwater flows northwest to southeast draining to the Lost River Diversion Canal or the Lost River. It is reported that the groundwater gradient is approximately three feet per mile (Sammel, 1980). The diversion canal is used to regulate water release from Upper Klamath Lake and to allow transfer of water between the westward flowing Klamath River basin or the southward flowing Lost River basin which drains to Tule Lake in northern California.

National Weather Service mean annual precipitation for Kingsley Field is 13.65 inches, and the Oregon State Water Resources Board calculates evapotranspiration for the area to be 15.6 inches per year. These figures indicate a net water loss of 1.95 inches per year, but the extensive watershed which drains to the Lower Klamath Lakebed is responsible for the abundance of groundwater. The surrounding mountains are responsible for the amount of water which reaches the basin as rainfall, snow or run-off. Moisture which moves east from the Pacific Ocean is stopped by the Cascades so the majority of the water which reaches the lakebed is run-off from the eastern flanks of the mountains. Most precipitation which does reach the valley is in the form of snow. Historical records demonstrate that 60 to 70 percent of the total precipitation occurs from October through March.

Local off-base residential and agricultural water supplies are from privately owned shallow wells. There are approximately 15 private homes within a 1/2 mile radius of Landfill No. 3. Kingsley Field water supplies are provided by water lines from the City of Klamath Falls.

Kingsley Field is not located in an environmentally sensitive area. The Pacific Flyway passes through the Klamath Basin and there are important breeding grounds for pelicans, great blue herons and cormorants west of Kingsley Field in marsh areas of the Klamath River, but these breeding grounds are not

impacted by base activities. The major sign of environmental stress is that of vegetation control through mowing. This control of ground cover has limited the proliferation of wildlife communities within the base boundaries.

Historically, base activities which might have contributed to the generation and disposal of hazardous wastes include vehicle, support equipment and aircraft maintenance, landfills, pest control and fuel storage. The IRP Phase I report states that prior to 1979, essentially all solid wastes generated, except for mess hall wastes, were disposed of on base property. The mess hall wastes were transported off base. Since 1979 all wastes have been disposed of in off-base disposal sites. Each of the original base landfills was constructed as a trench type landfill. Open burning was conducted at two of the three landfill sites. As for the hazard potential of wastes generated by maintenance activities, pest control or fuel storage, trace residual of pesticides and herbicides quite possibly pose the greatest threat as their use has been widespread around the base in keeping the land adjacent to runways, in POL storage areas, fence lines and transformer pads free of vegetation.

3.0 FIELD PROGRAM

3.1 PURPOSE

Field investigations around Landfill No. 3 included an electrical resistivity survey to identify the depths to groundwater and local groundwater flow direction, and the siting and drilling of two groundwater monitoring wells hydraulically downgradient of the landfill. Once completed, groundwater samples from these new wells plus water samples collected from two nearby residential wells were analyzed for selected inorganic and organic compounds representative of wastes believed to be buried in the landfill.

3.2 ELECTRICAL RESISTIVITY SURVEY

The geophysical exploration at Kingsley Field was performed by Foundation Sciences, Inc. (FSI) during the period 13 September 1983 through 16 September 1983. The geophysical exploration consisted of seven electrical resistivity stations. The locations of the stations were selected by FSI and are shown in Figure 3. The resistivity data are summarized in Table 1. Raw resistivity data and apparent resistivity curves are contained in Appendix E. Inhomogeneity in surficial soil and interference from nearby electrified fences and overhead power lines precluded analysis of the data from Station 7. The intent of this investigation was to estimate the depth to the groundwater table at various locations around Landfill No. 3. The information obtained was used to assist in locating sites for the two groundwater monitoring wells.

A Bison Model 2350 Earth Resistivity Meter and a Wenner Electrode array were used for the electrical resistivity profiling. In order to determine apparent resistivity as a function of depth, electrode spacing was increased in increments of two feet or four feet along electrode array lengths of four to 48 feet. The log of apparent resistivity versus the log of electrode spacing is then plotted, and the data are fitted using a horizontal two-layer model. The master curves of Orellana and Mooney (1972) were used for curve fitting.

The resistivity of the top layer is determined from the intercept of the master curve abscissa along the ordinate of the apparent resistivity versus

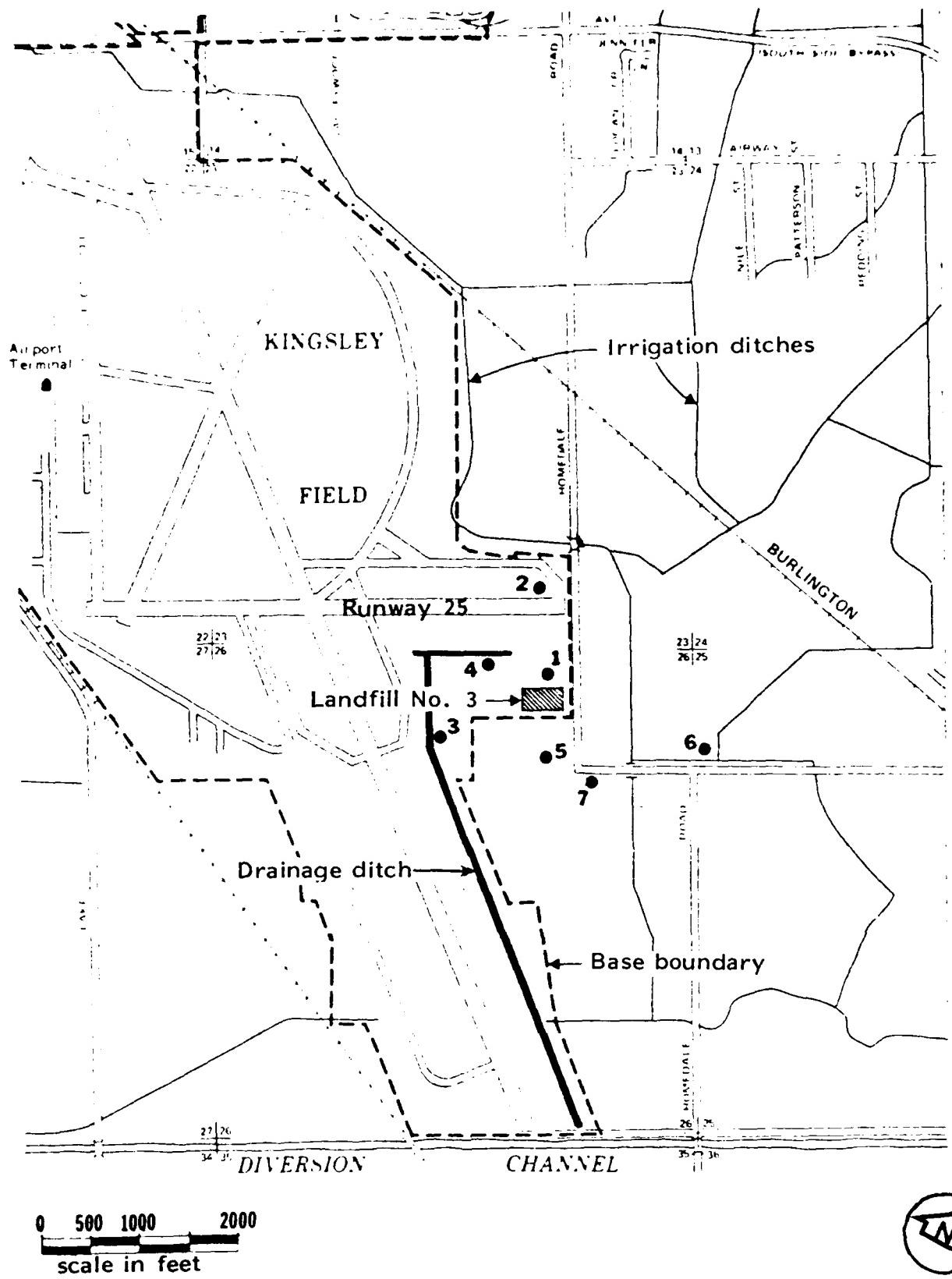


Figure 3
LOCATION MAP OF ELECTRICAL RESISTIVITY STATIONS
AT KINGSLEY FIELD

Table 1
SUMMARY OF ELECTRICAL RESISTIVITY DATA

<u>Station Number</u>	<u>Relative Elevation^a (ft)</u>	<u>Actual Elevation^b (ft above MSL)</u>	<u>Resistivity (ohm-ft)</u>		<u>Depth to Interface (ft)</u>
			<u>Layer 1</u>	<u>Layer 2</u>	
1	100.0	4082.7	18	181	2.0
2	100.5	4083.2	46	184	18.5
3	101.0	4083.7	36	18	3.8
4	101.0	4083.7	41	145	13.5
5	102.5	4085.2	42	131	7.8
6	105.0	4087.7	73	219	5.3
7	103.0	4085.7	--	--	--

^aElevations as measured in the field relative to elevation equals 100.0 ft at Station No. 1.

^bBased upon field survey and reference elevation of 4088.0 ft MSL near VOR facility. No survey bench mark is known to exist in the Runway 25 area.

NOTE: Field survey performed 13-16 September 1983.

electrode spacing curve. This point is labeled L1 on the apparent resistivity plots. The resistivity of the second layer is determined by multiplying the resistivity of the first layer by the model multiplication factor, F. The depth to the interface is determined from the intercept of the master curve ordinate along the abscissa of the apparent resistivity versus spacing plot. This point is labeled D on the plots. Additional details of the technique can be found in many introductory geophysics texts (e.g., Telford et. al., 1976).

Absolute elevation data were not available at the time of the field work. Therefore, the elevations listed in Table 1 are referenced to an assumed elevation of 100 feet at Station 1. Relative elevations were measured by FSI personnel at the time of the geophysical study using a hand level. JRB personnel surveyed estimated elevations at the time of the second groundwater sampling event. In the absence of a survey benchmark elevation, the elevations are referenced against the reported surface elevation of 4088.0 ft MSL near the VOR facility approximately 800 feet south and west of Landfill No. 3. The elevation data are accurate to +0.5 feet.

Generally, the resistivity of saturated material is expected to be less than the resistivity of dry material. Except for Station No. 3, the data in Table 1 indicate that if the interface depth is the depth to the top of the water table, then the saturated material has a higher resistivity than the dry surface material. A possible explanation for this unexpected observation is that application of fertilizer over the years has resulted in an accumulation of salts in the upper few feet of soil. Since salts are very conductive of electrical current, the presence of salts in the shallow soils would reduce the electrical resistivity. However, the fertilizer salt concentrations would be diluted by groundwater flow at depth. Therefore, the resistivity of the saturated soil would be greater than the resistivity of the dry soil.

3.3 MONITORING WELL LOCATION

The locations of groundwater monitoring wells KZ01 and KZ02 are shown in Figure 4. Their locations north and west of the landfill are different than those specified in the Task Order and would at first appear to be located hydraulically upgradient of Landfill No. 3 based upon preliminary interpretations of regional groundwater flow. However, based on our discussions with

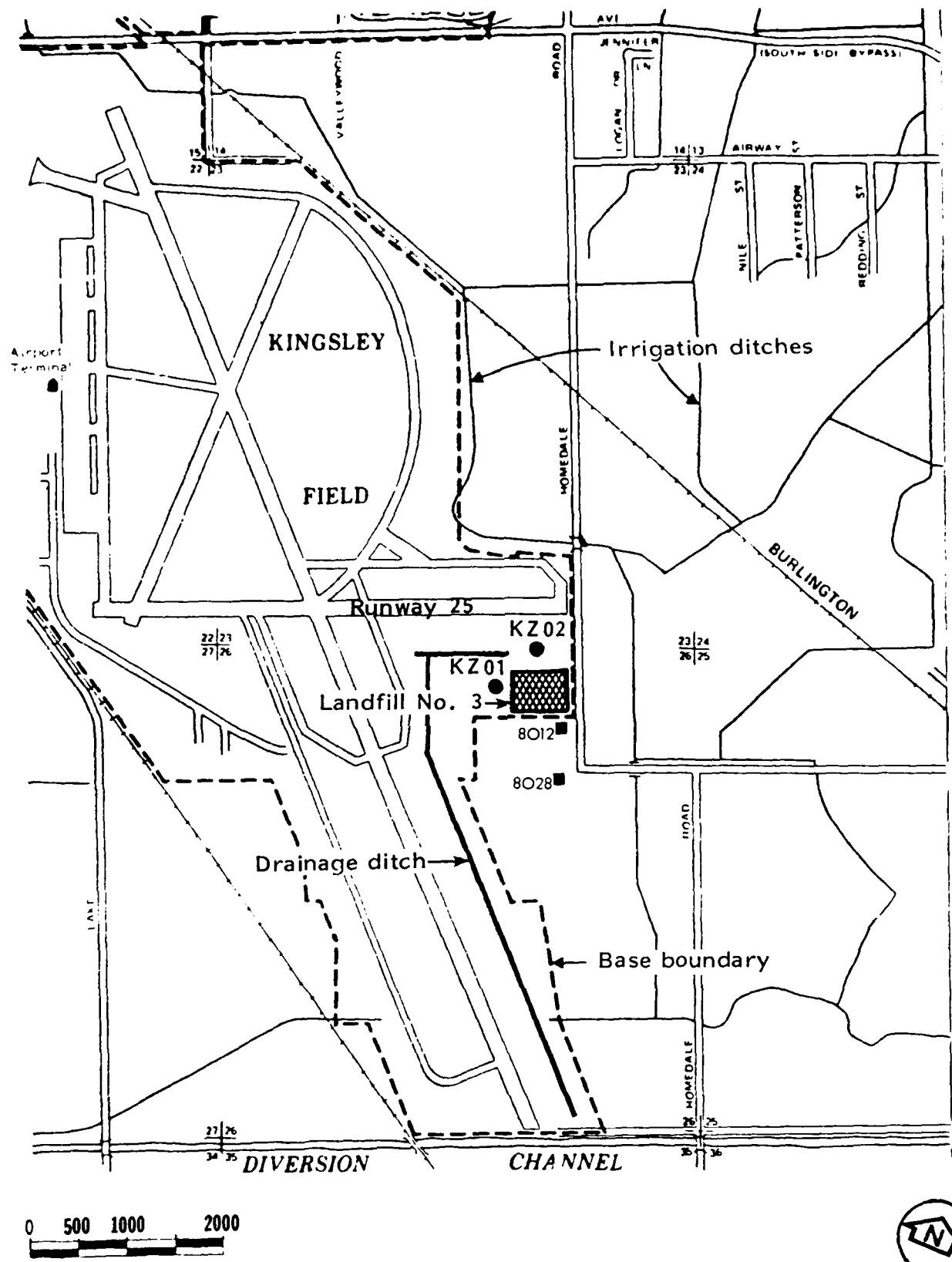


Figure 4

LOCATION OF MONITORING WELLS KZ01 AND KZ02, AND
RESIDENTIAL WELLS SELECTED FOR GROUNDWATER CHARACTERIZATION
AT KINGSLEY FIELD

base personnel and observations made at the site, at least the summertime near-surface flow of groundwater in the vicinity of Landfill No. 3 appears to be influenced by local irrigation. Most of the land outside of the base boundary is flood-irrigated, while no flood irrigation occurs on the base. Therefore, percolation of flood irrigation water into the soils causes mounding of groundwater outside of Kingsley Field property boundaries and a localized reversal in direction of groundwater flow in the vicinity of Landfill No. 3. It is hypothesized that at least during periods of flood irrigation that mounded groundwater beneath Landfill No. 3 flows in a northwest direction.

With the exception of the results obtained from Station No. 5, the results of the electrical resistivity profiling generally support this model. Therefore, the locations of groundwater monitoring wells KZ01 and KZ02 were located west and north of Landfill No. 3, respectively. These locations are, at least during the summer and other irrigation seasons, hydraulically downgradient of the potential contaminant source.

Figure 4 also shows the locations of the two homes from which domestic well water samples were taken (8012 and 8028 Homedale Road). These homes were selected over others in the area because they are the closest homes to the landfill and in a direction believed to be hydraulically downgradient from the landfill at least during the winter months. Because of the observed mounding of groundwater during periods of flood irrigation, these same two homes are believed to be hydraulically upgradient of the landfill during the warm and dry summer and fall months. The subsurface conditions and materials at Kingsley Field were investigated with two 78 foot borings. Upon completion of drilling, monitoring wells were installed. Well drilling and monitoring well installation began on 18 September 1983 and was completed on 19 September 1983. The monitoring wells have been identified using an alphanumeric code developed by JRB. The first letter of the code (K) indicates the area (Kingsley Field) in which the well was drilled. The second letter "Z" indicates that only one shallow monitoring well was placed within each bore hole, and the number following the two letter code identifies the numerical order in which the well was drilled.

3.4 DRILLING AND SOIL SAMPLING

The drilling and soil sampling of the two bore holes was performed using a truck-mounted, Mobile B-61 drill rig owned and operated by Subterranean, Inc., of Sumner, Washington. The borings were made using a 3-3/8 inch inside diameter hollow stem auger. The outer diameter of the drilling auger is approximately eight inches. Each well boring was made to a depth of 78 feet. All drilling activities and techniques were overseen by an experienced JRB staff geologist. The geologist maintained a detailed log of all materials encountered during the course of the work.

Undisturbed sediment and soil samples were recovered through the hollow stem auger at five-foot depth intervals. All samples were obtained using a standard split spoon sampler. A Standard Penetration Test was performed at the time of sampling by driving a standard split spoon sampler into the soil a distance of 18 inches using a 140 pound hammer dropped 30 inches. The number of blows required to drive the sampler the last 12 inches is known as the Standard Penetration Resistance or N-value. The N-values provide a relative measure of the degree of compactness of granular soils such as sand, and the degree of softness or stiffness of cohesive soils, such as clays or silts. The soil obtained in the split spoon sampler was visually examined and logged by the geologist. Representative portions of each sample were saved in air-tight glass jars for future chemical or grain size analyses. All samples were transferred from the split spoon sampler to 16 ounce wide mouth glass jars with Teflon® spatulas. The jars were additionally sealed with a Teflon® inner cap liner. All samples were labelled with a code containing the date and time, well identification, sample depth and the name of the person collecting the samples. Any soil material remaining in the split spoon sampler was saved for more detailed visual geologic analysis. Each split spoon sampler was thoroughly cleaned in a mild soap solution ("Alconox"), rinsed with reagent grade methanol, and allowed to dry before reuse.

3.5 WELL INSTALLATION

Monitoring wells were installed in each of the borings upon completion of borehole drilling and sampling. Each of the wells was constructed with two-inch I.D. schedule 40 PVC pipe which was inserted to the bottom of the boring through the inside of the hollow stem auger.

Ten-foot lengths of threaded sections of slotted PVC pipe (slot size 0.010 inch) were screwed together to form the well screen. A threaded end cap was attached to prevent soil materials from entering the bottom of the well casing. In well KZ01 the slotted PVC pipe extends from 2.5 feet below ground surface to the bottom of the boring (78 feet below ground surface), and in well KZ02 the slotted PVC pipe extends from the ground surface to a depth of approximately 68 feet below ground surface. Problems with equipment becoming lodged in the PVC casing during well development at KZ02 resulted in the string of casing being pulled up 10 feet during the equipment retrieval process. This later loss of 10 feet of installed casing explains the 10-foot difference in total depth drilled and resultant depth cased. The top portion of each monitoring well was constructed by threading additional sections of blank PVC above the screened portion. Approximately two to three feet of PVC extends above the ground at each of the wells.

Threaded PVC pipe was used to avoid contaminating the well with trace levels of plasticizer adhesive solvents. The augers were removed once the PVC pipe was set on the bottom of the boring inside the hollow stem of the auger. As the auger was removed, the unconsolidated sands and silts collapsed in and around the PVC pipe. However, to protect the well from possible direct surface contamination, the annular space between the PVC well and the walls of the boring in at least the top ten feet of the boring was filled with clean granular material and a near-surface seal of bentonite was placed in the hole around the PVC pipe. Finally, a six-inch diameter protective steel casing with a locking cover was placed over the exposed PVC well pipe and grouted in place. A typical monitoring well installation is shown in Figure 5. Appendix D contains the monitoring well construction summaries.

3.6 BOREHOLE LOGS

Logs of borings for the monitoring wells installed at Kingsley Field are presented in Appendix D. Each log shows the various types of materials that were encountered in the boring and the depths and elevations where the materials and/or the characteristics of the materials changed. The number and types of the samples that were taken during the drilling are indicated in the column to the right of the geologic description. In the next column, the depths of well screens and blank well casings are shown graphically. Also

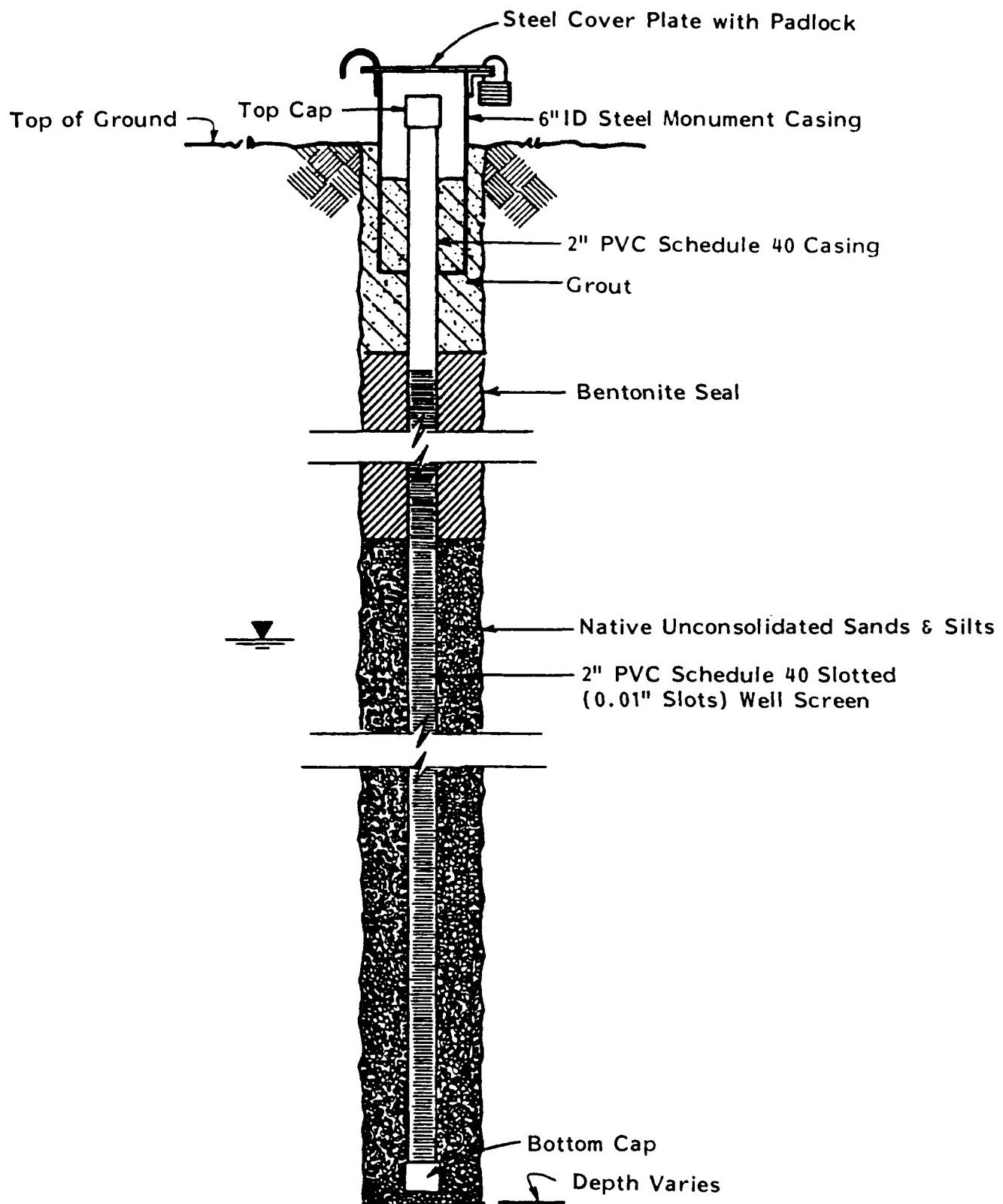


Figure 5

DETAIL OF MONITORING WELLS AT KINGSLEY FIELD
(NOTE: slotted pipe extends to the ground surface at well KZ02)

shown in this column are measured groundwater levels, and the dates on which the measurements were made. Farther to the right are plotted the standard penetration resistance, or N-values, that were recorded during the split-spoon sampling. Table D-1 defines the various modifiers used to describe soil classification and consistency on the boring logs. The patterns used to identify stratigraphy for each boring log approximate the Standard Geologic Symbols for Unconsolidated Materials, varying slightly due only to the availability and style of graphic art materials. The symbols used in the boring logs are presented in Appendix D as Figure D-1.

Table 2 presents a summary of the location and physical description of the two boreholes, the zones at which the installed monitoring wells are screened, and the actual dates of drilling and well installation.

3.7 DEVELOPMENT OF MONITORING WELLS

Well development, the final step in completing a well, is the process of removing silts and other fine-grained sediments from the aquifer in the vicinity of the well screen. This removal of fine sediments restores the permeability of the geologic formation disturbed during drilling so that water can enter the well more freely. Monitoring well development techniques used at Kingsley Field included a jet pump and an air lift pump. A single pipe jet pump, normally used in water production wells, proved ineffective when attempting to develop the wells with slotted PVC pipe.

Compressed air was used for well development once the jet pump proved to be an inefficient development technique. One half inch I.D. Schedule 80 PVC pipe was combined in 10-foot lengths and inserted in the two-inch I.D. well casing (see Figure 6). Compressed air was supplied to the 1/2-inch PVC pipe at a maximum pressure of 120 psi. Air-lifting of groundwater and fine-grained sediments was conducted at each well for over one hour during which time an estimated 300 gallons of water (30 casing volumes) had been pumped. Both pH and specific conductance measurements were taken to test groundwater stability. Sporadic readings later attributed to voltage drops across the probe leads, caused the abandonment of these data. Instead, well development was considered complete when suspended particulates were noticeably absent and water turbidity became stable over a 5 to 10 minute period.

Table 2
SUMMARY OF PHASE II IRP WELLS

<u>Well Name</u>	<u>Date Drilled</u>	<u>Location</u>	<u>Depth Drilled (ft)</u>	<u>Depth Cased (ft)</u>	<u>Depth Screened (ft)</u>
KZ01	830919	West of Landfill #3 South of Runway 25	078.0	078.0	002.5-078.0
KZ02	830919	North of Landfill #3 South of Runway 25	078.0	068.0	000.0-068.0

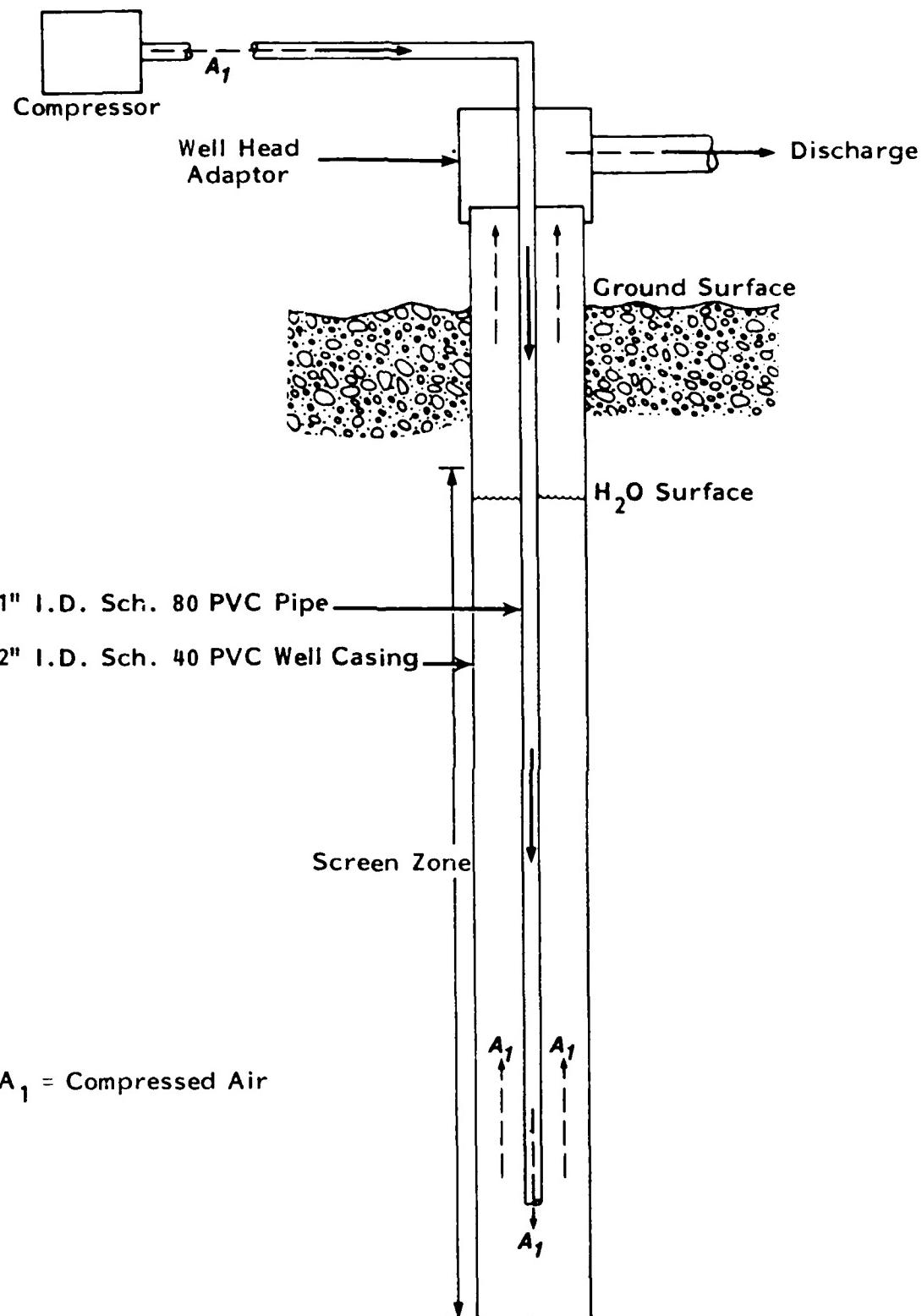


Figure 6

SCHEMATIC OF TYPICAL AIR LIFT ASSEMBLY USED IN WELL DEVELOPMENT
 (Note: Not drawn to scale)

3.8 SAMPLE COLLECTION AND PREPARATION

Groundwater samples were collected from wells KZ01 and KZ02 the morning after the wells were developed. Prior to sample collection both wells were again flushed to insure that well stagnation would not bias the analytical results. Flushing was accomplished with a hand bailer by extracting 20 liters of water, a quantity equivalent to three well casing volumes. Additionally, both domestic well pumps were run for 15 to 20 minutes each prior to sample collection from a water spigot in each pump house. This pumping served to flush from the water system any stagnant water in the hydropneumatic tanks or water supply lines.

All sample bottles and field equipment were prepared and sorted prior to the sampling event. Samples scheduled for volatile organics analysis were collected in duplicate and placed in 40 ml bottles with Teflon®-lined septum caps. These bottles were always field checked to insure no air or gas bubbles were entrained when the bottle was capped. Pesticide fractions were collected in one gallon amber glass bottles. Total organic carbon, chemical oxygen demand, and oil and grease fractions were collected in a one-gallon amber glass bottle and fixed with five ml of nitric acid in the field to reduce the pH to less than 2.0 pH units. Samples for total iron and chloride analyses were each collected in one-liter linear polyethylene bottles. Two ml of nitric acid was added to the iron sample to reduce the pH to less than 2.0 units. All bottles had been prepared by acid rinse and heating in the laboratory.

Water samples for pollutant analyses were collected using a bailer constructed entirely of Teflon® components. The bailer was 29 inches in length with an outside diameter of 1.75 inches. When full the volume of the bailer was approximately 0.8 liters. A Teflon® ball built into the base served as a lower check valve. The bailer was lowered into the well on a nylon monofilament line. The used length of line was discarded after each well was sampled to avoid possible transfer of contaminants to other wells. The bailer was washed with a mild detergent solution ("Alconox") and rinsed with methanol prior to sampling either well.

Samples taken from the two domestic wells were grab samples taken directly from a water spigot in the pumphouse. At wells KZ01 and KZ02 a composite sample throughout the total available water column was collected and analyzed. Sampling proceeded from the top of the water column to the total depth of the well to minimize the effect of turbulence within the well casing. The sampling team determined in the field the vertical position of the bailer and the frequency of samples pulled from the wells to insure that sufficient volumes of water were collected throughout the water column to fill all sample bottles. For example, in a well with an 80-foot water column, the saturated zone was divided into four equal well sectors of 20 feet each. One quarter of each resultant composite sample would itself be a representative composite from each of the 20-foot sectors. Sampling would begin by withdrawing one bailer of water from the surface of the groundwater table. The two 40 ml bottles for volatile organics would be filled and capped and the remaining water volume would be drained into a clean one-gallon field composite bottle. Additional water samples would be bailed from well depths of five, 10 and 15 feet below the water table. Each sample would in turn be emptied into the field composite bottle. The one-gallon field composite bottle containing the four bailer volumes would be mildly agitated and its contents transferred into the set of four bottles targeted for chlorinated pesticides and TOC, COD, oil and grease, and total iron and chloride sample analyses until each of these lab sample bottles had received 25 percent of their respective volumes. The field composite bottle was then emptied and bailing would begin in the second 20-foot sector of the water column. This quartering technique was repeated throughout the remaining three 20-foot sectors of the saturated zone until the entire 80-foot water column had been sampled. The field composite bottle was then discarded after all laboratory samples had been collected. The bailer was cleaned and a new field composite bottle selected for sampling the second well.

Sediments in the bottom of the wells occasionally caused the check valve ball to improperly seat itself. This would result in the loss of part or all of the water sample during transit between the point where the bailer broke through the water surface and the top of the protective casing.

Once all the samples were collected, the bottles were sealed, labeled and wrapped in bubble packing material and placed in coolers. At the end of the day all samples were inventoried against the field log notes and a sample chain of custody log (see Appendix F) was prepared. All samples were packed in shipping coolers, covered with ice, and the coolers were sealed and secured. Breakaway and/or tear resistant tape was used to seal the coolers per chain of custody protocols. All tape seals were signed by the sampling team leader. The samples were then air-expressed to the JRB Trace Environmental Chemistry Laboratory in La Jolla, California. Upon arrival at the lab, all samples were inventoried against the chain of custody log and the sample bottles inspected for sample integrity. Once a lab identification number had been assigned to each sample, the chain of custody log was signed and a copy was returned to JRB-Bellevue, Washington Office for confirmation of receipt.

4.0 DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

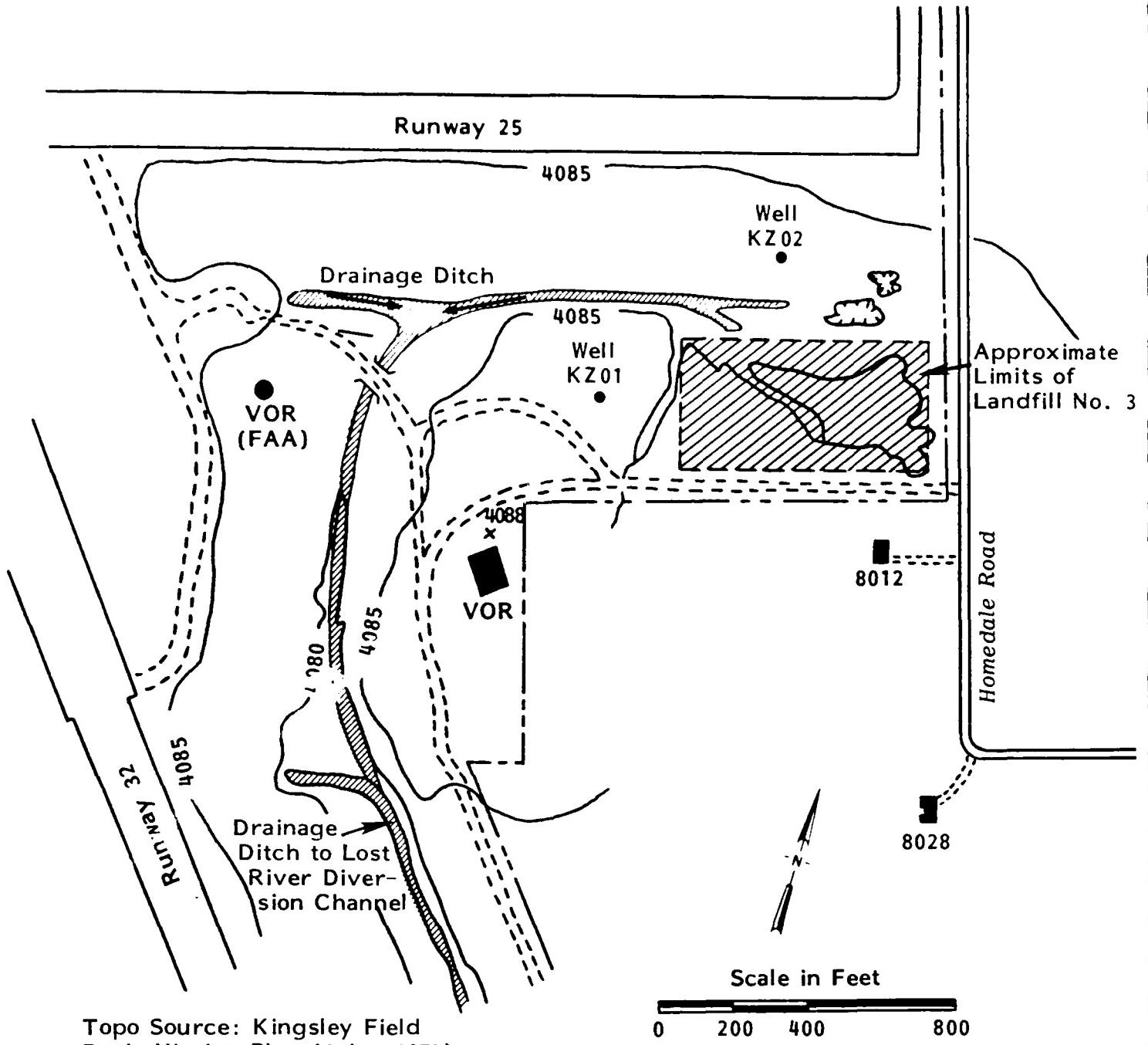
4.1 GEOHYDROLOGIC INTERPRETATIONS

The two shallow borings (each 78 feet deep) made for this study supplement existing knowledge of the local geology. The boring cuttings indicate that the subsurface materials are generally lacustrine sands, silts and clays. The sediments are the erosional products of the surrounding mountains which were carried into the basin by a complex network of surface drainages.

The electrical resistivity survey performed by Dr. Michael Feves of Foundation Sciences, Inc. consisted of seven stations and was performed to gather information on depths to the water table in the immediate vicinity of Landfill No. 3. These data were used to determine the seasonal direction of groundwater flow and to assist in locating sites for the two groundwater monitoring locations.

Landfill No. 3 is bounded on the east by farmland, which uses flood irrigation techniques, and on the south by private property owners who intermittently irrigate pasture lands. Local near-surface groundwater flow appears to be influenced by this irrigation to the extent that surface groundwater flow is seasonally reversed from that reported for the regional groundwater movement. During periods of flood irrigation a local groundwater mound is created which forces the near-surface groundwater back onto the base. The shallow irrigation drainage ditches on the base also appear to affect local near-surface groundwater flow. The location of these drainage ditches and groundwater table elevations as recorded during each of the two sampling events are presented in Figure 7.

It was observed in September 1983 that farmlands east of Homedale Road were flooded but pastures south of Landfill No. 3 were dry. The groundwater surface elevation in monitoring well KZ01 as measured in September, 1983, was approximately six feet lower than the groundwater table elevation in well KZ02. There are at least two explanations to account for this difference in groundwater elevation. One is that the landfill and landform changes adjacent to the landfill have altered the soil's permeability and related hydraulic



**GROUNDWATER TABLE ELEVATIONS
(feet MSL)**

Date	KZ01	KZ02
830919	4072.3	4078.5
840409	4078.6	4078.5

Figure 7

**LOCATION OF DRAINAGE DITCH AND MONITORING WELLS
NEAR LANDFILL NO. 3 AND IDENTIFICATION OF
SELECTED WATER TABLE ELEVATIONS**

properties, perhaps limiting the lateral extent of the groundwater mound caused by flood irrigation. Second, near-surface groundwater flow, itself influenced by local flood irrigation, may partially be intercepted by the drainage ditch which lies between the two wells. This shallow drainage ditch channels water in a westerly direction and thence into a ditch which flows south to the Lost River Diversion Channel. During the September sampling event, this ditch was noticeably wet and carrying water away from the southeast disposal area. When visited in April 1984, the seasonal water table had risen to elevation 4078.5 on both sides of the ditch, which now contained water at a depth of three or more feet. In the absence of any ongoing irrigation, the water table as measured on either side of the drainage ditch had approximately equal elevations. Land surfaces both east of Homedale Road and south of Landfill No. 3 were wet and had ponded water.

This hypothesis of the local effects of irrigation is further supported by the groundwater table elevations as estimated at six stations in the electrical resistivity survey and reported in Table 3. Combining the geophysical interpretations of the suspected water table with measured water table elevations (see Figure 7), one can plot the estimated groundwater table contours as illustrated in Figure 8. This interpretation suggests there is at least a seasonal westward flowing plume of shallow groundwater caused by the flood irrigation practices of agricultural lands east of Homedale Road and south of Landfill No. 3. During periods of such irrigation any leachate migrating from Landfill No. 3 would be moving onto Kingsley Field. During periods of little or no irrigation, however, shallow groundwater flow is believed to reverse direction and flow in a southeast direction consistent with the regional groundwater flow (CH2M-Hill, 1982). This hypothesis is partly supported by the April 1984 water table elevation data which suggest that wells KZ01 and KZ02 lie along the same 4078.5 ft elevation contour line. In this latter situation, any leachate from Landfill No. 3 could be moving away from Kingsley Field and towards the residential/agricultural areas south and east of the landfill.

4.2 GROUNDWATER CHEMISTRY

Each monitoring well and private well was sampled according to the procedures described in Section 3.8. The samples were shipped air express to the JRB Trace Environmental Chemistry Laboratory for chemical analysis. The methods

Table 3
GROUNDWATER TABLE ELEVATIONS AT ELECTRICAL
RESISTIVITY STATIONS AT KINGSLEY FIELD, OREGON
(feet MSL)

<u>Date</u>	Station Number						
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>	<u>7</u>
830916	4080.7	4064.7	4079.9	4070.2	4077.4	4082.4	---

NOTE: Estimated groundwater table elevations are differences between ground surface elevations and depth to electrical resistance interface (see Table 1).

Topo Source: Kingsley Field
Basic Mission Plan (1 Jan 1974)

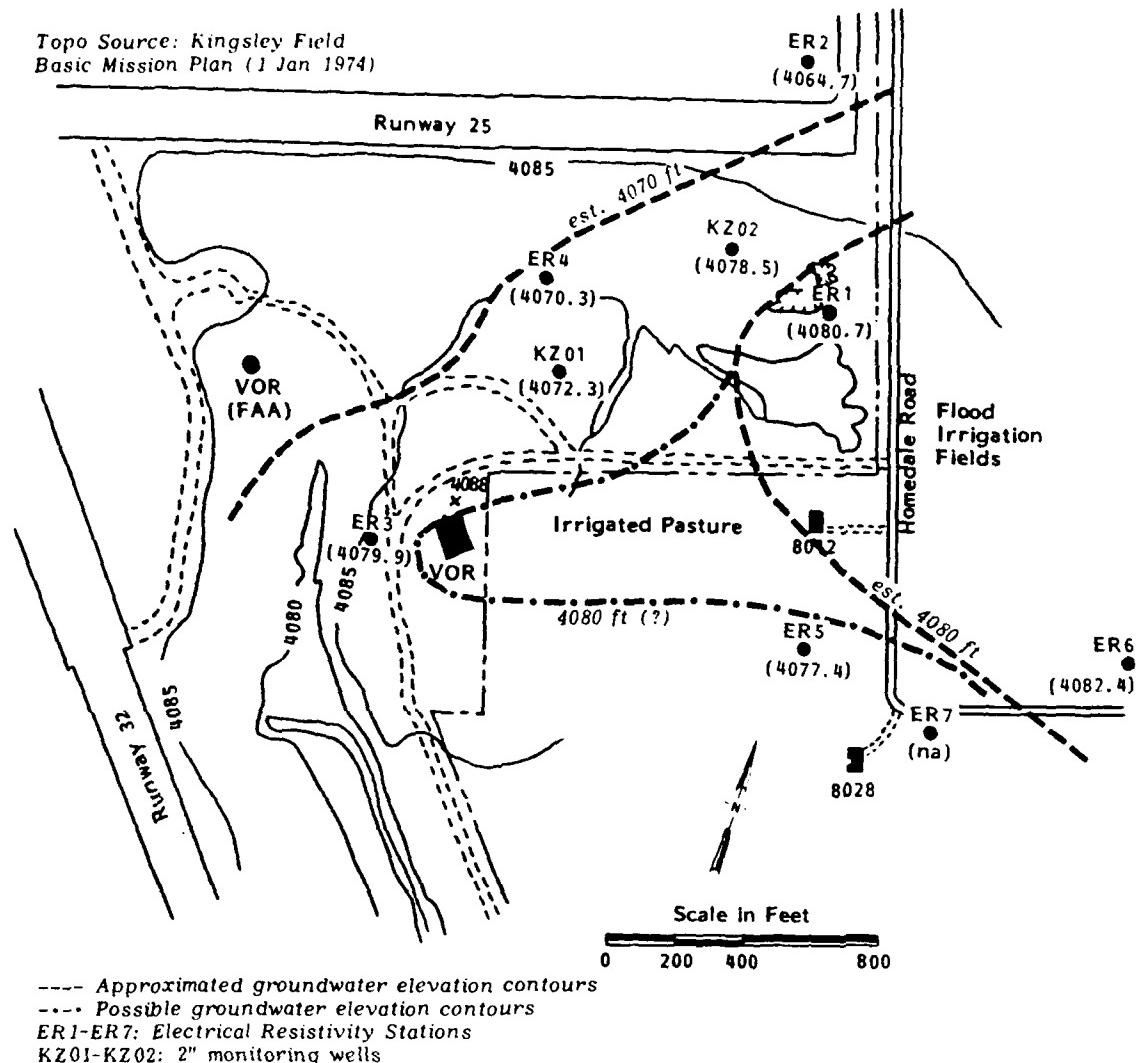


Figure 8

16 SEPTEMBER 1983 GROUNDWATER TABLE ELEVATIONS
AS APPROXIMATED BY ELECTRICAL RESISTIVITY
AND MONITORING WELL MEASUREMENTS

employed in sample preparation and chain of custody are identified in Appendix F. All the data were reviewed and verified by JRB laboratory personnel. The data were then forwarded as hard copy outputs to the JRB-Bellevue Office for tabulation and interpretation. All the raw chemistry data are also presented in Appendix G.

Groundwater samples taken from the two monitoring wells and two private residences were analyzed for the following parameters:

- Total Iron and Chloride - These parameters are an indicator of landfill leachate and may be used to assess leachate migration.
- Total Organic Carbon (TOC) - A measure of organic carbon content, and an indicator of organic compound contamination in the groundwater. With respect to the suspected waste materials believed to have been disposed of in Landfill No. 3, it is an indicator of petroleum, lubricants or solvents, or landfill leachates from putrescible wastes.
- Chemical Oxygen Demand (COD) - A measure of the oxygen equivalent of the organic matter content of a sample susceptible to chemical oxidation. The COD test is a test which may indicate the presence of landfill leachates or other contaminants in the water or sediments.
- Oil and Grease - Any petroleum or oil base substance. The presence of oil and grease residuals in groundwater may be an indicator of past landfill practices such as disposal of fuel, waste oils or lubricants.
- Chlorinated Pesticides - Used extensively for insect and weed control and which are generally both toxic and persistent. Pesticide contamination may be indicative of less than optimal pesticide and herbicide application practices or failure to properly rinse pesticide containers prior to their disposal.
- Purgeable Halocarbons and Aromatics - Two groups of organic compounds (32 total) which frequently are components in solvents, degreasing agents and industrial grade petroleum-based products commonly used for aircraft and engine maintenance and other base industrial applications. Table 4 is a list which identifies these organic compounds. Presence of these compounds in groundwater normally means their presence in the landfill.

4.3 DISCUSSION AND INTERPRETATION OF ANALYTICAL DATA

The two sampling events at Kingsley Field were scheduled such that the groundwater was sampled during both seasonal low and seasonal high groundwater

Table 4

COMPOUNDS IDENTIFIED DURING PURGEABLE HALOCARBON
EXTRACTION (EPA Method 601) AND PURGEABLE AROMATIC
EXTRACTION (EPA Method 602)

Purgeable Halocarbons
(EPA Method 601)

Bromoform
Bromodichloromethane
Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chloromethane
2-Chloroethylvinyl-ether
Chloroform
Chloroethane
Dibromochloromethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene
Trans-1,2-Dichloroethylene
1,2-Dichloropropane
Cis,1,3-Dichloropropene
Trans-1,3-Dichloropropane
Methylene Chloride
1,1,2,2-Tetrachloroethane
Tetrachloroethylene
1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

Purgeable Aromatics
(EPA Method 602)

Benzene
Chlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Ethylene Benzene
Toluene

periods. The first sampling took place on 19 September 1983 just after the installation of the two monitoring wells. This sampling was scheduled as the seasonal low groundwater event. September is near the end of the dry season and is the time of year when the groundwater is at or nearing its lowest level at Kingsley Field. Field measurements did indicate that the water table is lower in September than the late spring months (see Appendix D, pages D-1 and D-2), particularly in Well KZ01. The water table elevation at well KZ01 appears to be less influenced by off-base flood irrigation activities than is well KZ02, perhaps due to the drainage ditch near Landfill No. 3 serving as a cutoff of westward flowing shallow groundwater, or reduced transmissivity and horizontal flow velocities caused by the landfill and other changes in land-form.

The second sampling event took place 9 April 1984 and was scheduled to coincide with the spring thaw and seasonal high groundwater period. Base personnel stated that groundwater was probably as high as it gets during an average year as indicated by winter precipitation patterns and because the ground surface was no longer frozen. The ground was also too wet and spongy to support the weight of a vehicle, and there was standing water in most ground surface depressions and in the drainage ditch. The private residence closest to the landfill (8012 Homedale Road) could not be sampled as electric power had been shut off at the pump house for several months and the well had not been in service. At the request of the occupants, electric service was restored to the pump house. However, efforts to secure a water sample were unsuccessful because the pump had lost its prime, and the priming tank and some of the water lines had been disconnected or damaged by frost.

Table 5 is a summary of groundwater chemical characterizations from the two monitoring wells near Landfill No. 3 and from two private residences south of the landfill. The groundwater chemical characterizations suggest there is a small amount of leachate which is being released from Landfill No. 3 and that the leachate is measurable in the two base monitoring wells but is not discernable in the off-base domestic water supply wells. The data, although limited to one sampling event in each of two seasons, further suggest:

Table 5

**GROUNDWATER CHEMICAL CHARACTERIZATIONS AS SAMPLED FROM KINGSLEY FIELD, OREGON
MONITORING WELLS AND OFF-BASE RESIDENTIAL WELLS**

Sample Location	Sample Date	Iron (mg/l)	Chloride (mg/l)	TOC (mg/l)	COD (mg/l)	Volatile Organics/		
						Oil & Grease (mg/l)	Chlorinated Pesticides (µg/l)	Hydrocarbons (µg/l)
KZ01	830919	31	400	4	270	ND	ND	ND
	840409	19	1000	28	140	ND	ND	ND
KZ02	830919	150	160	12	140	ND	ND	ND
	840409	25	90	6	26	ND	ND	ND
8028 Homedale Road	830919	0.58	130	150	1200	5.8	ND	15.3*
	831207	--	--	--	--	--	--	16**
	840409	0.32	150	6	16	ND	ND	ND
8012 Homedale Road	830919	0.71	87	5	26	ND	ND	ND
	840409	No sample available.		Water pump no longer electrified.	Well not in use.			

*Methylene Chloride.

**Sample retake to confirm suspect September results. Only volatile organics analysis performed.

1. The September 1983 sample collected from the well house at 8028 Homedale Road contained unusually high TOC, COD, and oil and grease concentrations and the lone confirmation of a volatile organic. Review of internal laboratory quality assurance minimized the potential for laboratory error as an explanation for these contaminant concentrations. A second set of water samples were collected on 7 December 1983 and volatile organics analysis confirmed the lone presence of methylene chloride at the previously measured concentration of 16 µg/l. Methylene chloride, detected at a very low concentration, is a common laboratory contaminant in EPA 601 and 602 methods. It is also recognized to be ubiquitous in the environment at trace concentrations and is frequently a component of many industrial degreasing or paint stripping compounds. It should be noted these samples were taken from the pumphouse near the garage and driveway, and that several large trucks on the property were undergoing some sort of rehabilitation. To minimize the possibility of field contamination, the April 1984 samples were taken from the kitchen cold water tap (tap aerator removed) after allowing all water lines to purge themselves for several minutes. The home owners reported that there are no in-line activated carbon or other treatment units which could remove water contaminants. This sample indicated no oil and grease or methylene chloride contamination, and TOC and COD concentrations are representative of those in other wells.
2. Elevated iron concentration in the on-base wells as compared to off-base water supply wells suggests that landfill leachate may be migrating from the landfill into the on-base surface aquifer but does not appear to have migrated to or adversely impacted the two domestic water supply wells.
3. On-base monitoring wells yielded higher groundwater COD concentrations than those off-base with the exception of the questionable September 1983 sample from the water supply well at 8028 Homedale Road. Groundwater TOC data are generally consistent among all four wells and are at uniformly low concentrations.
4. No oil and grease, chlorinated pesticides or volatile halocarbons and aromatics were identified in any of the four groundwater samples.

In review of data collected in the vicinity of Landfill No. 3 the groundwater does not appear to be adversely affected by the presence of the landfill and the groundwater used for domestic supplies continues to have good quality.

5.0 CONCLUSIONS

In continuation of the USAF Installation Restoration Program at Kingsley Field, a Phase II confirmation investigation was performed near Landfill No. 3 to determine the direction of groundwater flow, and to characterize chemical compounds in the groundwater migrating from this site.

Landfill No. 3 was a small landfill approximately two acres in size which received non-putrescible refuse, construction or demolition debris, coal fly-ash, and small quantities of unsecured pesticide and miscellaneous paint, thinner and solvent containers. These wastes were placed in this unlined landfill between the years 1961 and 1979 before the site was closed and a fill cover placed over the site. The cover was graded and seeded. Although permeable to incidental precipitation, the flat slope and a vegetated stabilized cover has prevented any measurable surface erosion by wind or water. With respect to the site investigation, one may conclude:

1. Regional groundwater is reported to flow in a northwest to southeast direction with a gradient of approximately three feet per mile. The absence of on-base wells or piezometers precludes the confirmation of this regionalized information.
2. Across the floor of the Klamath Basin the groundwater table is generally five to 15 feet below the ground surface. Seasonal water table elevations may fluctuate five to seven feet.
3. Numerous drainage ditches and diversion canals are placed throughout Kingsley Field and adjacent farmlands to facilitate soil dewatering and irrigation runoff. These drainage systems will cause localized influences on depth to shallow groundwater and the directional flow and velocities of that water.
4. Groundwater flow beneath Landfill No. 3 may be influenced by flood irrigation practices on adjacent off-base agricultural properties. Seasonal irrigation appears to cause the groundwater table to remain at or near its wintertime high beneath the irrigated land and the eastern edge of the fill. A drainage ditch was constructed on the western edge of the fill to convey surface run-off from runway facilities and adjacent open areas to the Lost River Diversion Channel. The ditch may also serve to dewater surface soils during seasonal off-base flood irrigation.
5. The groundwater table is estimated to be three to no more than 12 feet below the ground surface in the vicinity of Landfill No. 3. It is probable that the entire floor surface of the landfill, and possibly one-half of the fill volume, has been constructed in the zone of intermittent or continuous saturation.

6. Landfill leachate is being released to the shallow groundwater aquifer as measured by monitoring wells located north and west of the landfill. These wells were placed hydraulically downgradient of the landfill during seasonal groundwater flow conditions, but presumably upgradient of the landfill during periods of no off-site irrigation practices.
7. Base monitoring wells contain elevated concentrations of iron, and to a lesser extent COD and chlorides, as compared against off-base water supply wells. These contaminants are normal components of a landfill leachate. Of greater significance for the purposes of this report is the absence of measurable oil and greases, purgeable halocarbons and aromatics, and chlorinated pesticides in any of the monitoring or water supply wells. While not refuting the reported presence of these wastes in the landfill, the absence of these parameters in wells on either side of the landfill would suggest that the waste types or chemicals are present in the landfill in small quantities; that the chemicals have not yet mobilized or that they have failed to migrate in the direction of or as far as the four wells sampled; or that any chemical contamination in the landfill has already mobilized and migrated away from Landfill No. 3.
8. The absence of measurable concentrations of any regulated hazardous waste suggests that Landfill No. 3 is not an immediate threat to the public health or safety and does not cause any significant degradation of the environment.

As a consequence of the IRP Phase II investigations and resultant environmental data, Landfill No. 3 was rerated using the USAF Hazard Assessment Rating Methodology (HARM) employed during the Phase I studies (see Appendix I). Substituting field data and water chemical characterizations where appropriate, the new HARM score for Landfill No. 3 would be 51.5 instead of the HARM score of 66 received during the IRP Phase I study. While continuing to be the highest score received of the four sites ranked during Phase I, this lowered score indicates all sites warrant continued observation for environmental consequences but would generally not require remedial action.

6.0 RECOMMENDATIONS

In the absence of detected hazardous chemicals in either the base monitoring or off-base water supply wells, and the absence of records which confirm the presence of hazardous wastes or their quantities and locations in the landfill, it is recommended that the Air Force end their current IRP investigations at Kingsley Field, Oregon. However, a long-term monitoring program should be established using the two monitoring wells emplaced during this investigation. The purpose of this monitoring program would be to measure and record water quality and detect temporal changes which may provide changes in leachate migration rates or the presence of other chemical characteristics. Table 6 presents a recommended sampling program which can be carried out by base personnel with minimal impact on time and equipment. The wells should be sampled three times per year to monitor potential leachate migration, twice during the flood irrigation season and once during the non-irrigation season.

Prior to each sampling event the wells should be bailed to remove three or more casing volumes. For the given wells, this equates to approximately 30 volumes of a bailer with a capacity of one liter. Once the well has been bailed, the water sample can be taken at a single depth in the water column or a composite sample made of equal volumes taken at multiple discrete depths. Field experience has demonstrated that both wells can be flushed and sampled in approximately three hours. The chemical analyses can be performed locally or the samples packaged and shipped to USAF laboratories. It is recommended that data be plotted on graphs for visual detection of trends, and that running averages be investigated as well as interpretations on the total universe of data.

Whenever it appears an increased release of leachate may have occurred, the wells should be resampled and the same analyses replicated. If the replicated set confirms the previous findings, the on-base monitoring wells and the two off-base water supply wells should be sampled and analyzed for not less than the same suite of chemical parameters surveyed in this report.

Table 6

RECOMMENDED LONG-TERM MONITORING PROGRAM
FOR WELLS NEAR LANDFILL NO. 3
KINGSLEY FIELD, OREGON

<u>Well ID</u>	<u>Sample Frequency</u>	<u>Parameter</u>	<u>Critical Concentration</u>
KZ01 and KZ02	3/year ^a	Total Iron Chlorides TOC COD	250 mg/l ^b 2000 mg/l ^b 100 mg/l ^b 500 mg/l ^b
KZ01, KZ02, & Domestic Water Supplies (8012 and 8028 Home- dale Road)	As Necessary ^c	Total Iron Chlorides TOC COD Purgeable Halocarbons Purgeable Aromatics Oil and Grease Chlorinated Pesticides	0.3 mg/l ^d 250 mg/l ^d

^aTwo sampling events during field irrigation season and one sampling event during non-irrigated season.

^bRecommended concentration thresholds as measured in Wells KZ01 and KZ02 which trigger intensive investigation in monitoring and off-base supply wells. These values should be reexamined and redefined based upon long-term data results.

^cInitiated in response to elevated contaminant concentrations in base monitoring wells.

^dCurrently MCL concentrations defined by U.S. EPA Secondary Drinking Water Criteria.

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APPENDIX A
GLOSSARY OF TERMS AND ACRONYMS

GLOSSARY OF TERMS AND ACRONYMS

Alluvium: A general term for clay, silt, sand, gravel, or other similar detrital material deposited by a body of running water.

Andesite: A dark-colored, fine-grained extrusive rock, frequently of an igneous origin.

Aquifer: A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

AVGAS: Aviation Gasoline

Basalt: A general term for dark-colored, igneous rocks, commonly extrusive, chiefly of calcic materials where the percentage of silica is greater than 61 and the weight percentages of CaO, K₂O and Na₂O are equal.

BEE: Bioenvironmental Engineer

BMP: Best Management Practice

CE: Civil Engineer or Civil Engineering

COD: Chemical Oxygen Demand

Confined Aquifer: An aquifer bounded above and below by impermeable strata or by geologic units of distinctly lower permeability than that of the aquifer itself.

Contamination: The degradation of soil chemistry or natural water quality to the extent that its usefulness is impaired. There is no implication of any specific limits to water quality since the degree of permissible contamination depends upon the intended end use or uses of the water.

Dacite: A fine-grained extrusive rock with the same general composition of andesite but having more quartz (SiO₂).

DDT: Dichlorodiphenyltrichloroethane (a pesticide)

DEQPPM 81-5: Defense Environmental Quality Program Policy Memorandum 81-5.

Disposal Facility: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at a location at which the waste will remain after closure.

Disposal of Hazardous Waste: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwater.

DoD: Department of Defense

Down-dropped: A geologic unit on one side of a fault or slip plane which dropped while the other side was uplifted or raised.

DPDO: Defense Property Disposal Office, previously included Redistribution and Marketing (R&M) and Salvage.

Dump: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics. Dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers.

Effluent: A liquid waste discharged in its natural state from a manufacturing or treatment process. Such waste shall be partially or completely treated.

EPA: United States Environmental Protection Agency

Erosion: The wearing away of land surface by water or chemical, wind or other physical processes.

FAA: Federal Aviation Administration

Facility: Any land and appurtenances thereon which are used for the treatment, storage and/or disposal of hazardous wastes.

Fault: A fracture in rock along which the adjacent rock surfaces are differentially displaced.

Flow Path: The direction or movement of groundwater as governed principally by the hydraulic gradient.

Formation: A persistent body of igneous, sedimentary or metamorphic rock, having easily recognizable boundaries.

FSI: Foundation Sciences, Incorporated

Glacial: Pertaining to distinctive features and materials produced by or derived from glaciers.

Graben: An elongated, relatively depressed crustal unit bounded by faults on its long sides. Frequently expressed as a rift valley.

Groundwater: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.

HARM: Hazard Assessment Rating Methodology

Hazardous Waste: A solid waste or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

Hazardous Waste Generation: The act or process of producing a hazardous waste.

I.D.: Inside Diameter

Infiltration: The movement of water through the soil surface into the ground.

IRP: Installation Restoration Program

JRB: JRB Associates, a Company of Science Applications International Corporation

Lacustrine: Pertaining to, produced by, or formed in a lake or lakes.

Leachate: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water.

Leaching: The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

Liner: A continuous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents or leachate.

Loess: Accumulations of wind-borne dust. The dust is derived originally from desert area or from vegetation-free areas around ice sheets.

MCL: Maximum Contaminant Limit

MOGAS: Motor Vehicle Gasoline

Monitoring Well: A well used to measure groundwater levels and to obtain samples.

Moraine: A mount, ridge or other distinct accumulation of unsorted, unstratified glacial drift, predominantly till.

MSL: Mean Sea Level

Nonindurated: Non-hardened or non-cemented soils.

NORAD: North American Air Defense

Organic: Being, containing, or relating to carbon compounds, especially in which hydrogen is attached to carbon.

Perched Aquifer: Unconfined groundwater separated from an underlying main body of ground water by an unsaturated zone.

Percolation: Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil.

Permeability: The capacity of a porous rock, soil or sediment for transmitting a fluid without damage to the structure of the medium.

Plateau: A comparatively flat area of great extent and elevation; an extensive land region considerably above the adjacent country or above sea level.

Pleistocene: The latest period of time in the stratigraphic column. An epoch of the Quaternary period which began 2-3 million years ago.

POL: Petroleum, Oils and Lubricants

Pollutant: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose.

Porosity: The percentage of the bulk volume of a rock or soil that is occupied by interstices or openings whether large or small.

Potable Water: Water that is safe and palatable for human use; drinking water.

ppb: Parts per billion

ppm: Parts per million

psi: Pounds (pressure) per square inch

Pumice: A light-colored, glassy rock of volcanic origin. Very porous with closed void spaces, it is frequently buoyant enough to float on water.

PVC: Poly vinyl chloride (a plastic)

Quaternary Deposits: A system of rocks and strata deposited during the second period of the Cenozoic era. It began three million years ago and extends to the present.

RCRA: Resource Conservation and Recovery Act of 1976

Recharge: The addition of water to the groundwater system by natural or artificial processes.

Sedimentary Rock: A rock resulting from the consolidation of loose sediment that has accumulated in layers.

Sludge: Any inorganic or organic solids residues from a waste treatment plant, water supply treatment, or air pollution control facility; or other discarded material, including solid, liquid, semi-solid or solids which contain gaseous material resulting from industrial, commercial, mining or agricultural operations and community activities. Sludge does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges which are point source subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880); or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

Spill: Any unplanned release or discharge of a hazardous waste onto or into the air, land or water.

Static Water Level: The undisturbed water level measured in a well which represents the potentiometric surface for an aquifer. It is generally expressed as feet below (or above) an arbitrary measuring datum near land surface.

Storage of Hazardous Waste: Containment, either on a temporary basis or for a longer period, in such a manner as not to constitute disposal of such hazardous waste.

Strata: (Plural of stratum) Units or layers of sedimentary rock.

Subterranean: Formed or occurring beneath the earth's surface.

SWL: Static Water Level

TDS: Total Dissolved Solids

TOC: Total Organic Carbon

Toxic: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

Treatment of Hazardous Waste: Any method, technique, or process including neutralization designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize the waste or so as to render the waste nonhazardous.

TSS: Total Suspended Solids

TSD: Treatment Storage and Disposal

Unconfined: When used with groundwater, it is that groundwater that has a free water table; i.e., water not confined under pressure beneath relatively impermeable rocks.

Upgradient: In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of groundwater.

USAF: United States Air Force

USGS: United States Geological Survey

VOR: Visual Omni Range

Water Table: Surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

APPENDIX B

**IRP PHASE II SCOPE OF WORK
KINGSLEY FIELD, OREGON**

Installation Restoration Program

Phase II Field Evaluation

Kingsley Field, Oregon

I. Description of Work

A. Purpose: To determine if environmental contamination has resulted from waste disposal practices at Kingsley Field OR; and to provide estimates of the magnitude and extent of contamination, should contamination be found.

B. Background: The presurvey report (mailed under separate cover) and Phase I IRP report (mailed under separate cover) incorporate all background and description of the site for this task.

C. Technical Effort:

1. Conduct an earth resistivity or electromagnetic (EM) survey of the area to the south and southeast of landfill site 3. The results of this investigation shall be used to locate the two downgradient monitoring wells to be installed, and to provide a basis for selection of two other downgradient privately-owned water wells for sample collection and analysis.

2. Two ground water monitoring wells with depths equal to the depths of the nearby private wells (60 foot maximum) shall be installed downgradient (southeast) from landfill site no. 3 along the perimeter road. The exact location of wells shall be determined from results of the resistivity or electromagnetic survey. Standard penetration tests and split spoon sampling shall be accomplished as wells are installed. All wells shall be developed, water levels measured, and locations surveyed and recorded on a project map.

3. Water Sampling

a. Water samples shall be taken in sets of two from each monitoring well: one set at a time when the water table is at its highest level and one set at a time when water table is at its lowest level.

b. Two sets of water samples shall be obtained from two of the private water wells located to the south-southeast of landfill site 3. The private wells that will be sampled will be selected by results of the earth resistivity or electromagnetic survey. These samples shall be taken in sets of two: one set at a time when water table is at its highest level and one set at a time when water table is at its lowest level.

4. Ground water samples shall be analyzed for volatile organic carbon (VOC), total iron, chloride, total organic carbon (TOC), chemical oxygen demand (COD), oils and greases using IR Method and chlorinated hydrocarbon pesticides (as specified in Atch 1). The required limits of detection for the above analyses are given in Atch 1. All water samples shall be analyzed on site by the contractor for pH and specific conductance. Sampling, maximum holding time and preservation of samples shall strictly comply with

the following references: Examination of Water and Wastewater, 15th ed. (1980), pp. 35-42; ASTM, Part 31, pp. 72-82, (1976), Method D-3370; and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp. xiii to xix (1979).

5. Field data collected at the site shall be plotted and mapped. The nature of contamination and magnitude and potential for contaminant flow to receiving ground waters shall be determined or estimated. Upon completion of the sampling and analysis, the data shall be tabulated in the next R&D status report as specified in Item VI below.

6. Ambient air monitoring of hazardous and/or toxic material for the protection of contractor and Air Force personnel shall be accomplished when necessary, especially during the drilling operation.

D. Well Installation and Cleanup

Well installations shall be cleaned up following the completion of the well. Drill cuttings shall be removed and the general area cleaned.

E. Data Review

Results of sampling and analysis shall be tabulated and incorporated in the monthly R&D status report and forwarded to the USAF OEHL for review as soon as they become available as specified in Item VI below.

F. Reporting

1. A draft report delineating all findings of this field investigations shall be prepared and forwarded to the USAF OEHL as specified in Item VI below for Air Force review and comment. This report shall include a discussion of the regional hydrogeology, well logs of projects wells, data from water level surveys, earth resistivity or electromagnetic (EM) survey results, aquifer test results and conclusions, water quality analysis results, available geohydrologic cross sections, ground water surface and gradient maps, vertical and horizontal flow vectors and laboratory quality assurance information. The report shall follow the USAF OEHL supplied format (mailed under separate cover).

2. Estimates shall be made of the magnitude, extent and direction of movement of contaminants discovered. Potential environmental consequences of discovered contaminations shall be identified and estimated.

3. Specific requirements, if any, for future ground water and surface water monitoring must be identified.

G. Quality Assurance

The quality assurance specified in Section H, para (xxi) of the contract is applicable to this order.

II. Site Location and Dates:

Kingsley Field OR
Dates to be established

III. Base Support: None

IV. Government Furnished Property: None

V. Government Points of Contact:

1. Dr Dee Ann Sanders
USAF OEHL/TS
Brooks AFB TX 78235
(512) 536-2158

2. Col Jerry P. Dougherty
HQ TAC/SGPAE
Langley AFB VA 23665
(804) 764-2180

3. Lois F. Seibt
OLCC/25 AD/DE
Kingsley Field OR 97601
(503) 882-4411 Ext. 323

VI. In addition to sequence numbers 1, 5 and 11 listed in Atch 1 to the contract, which are applicable to all orders, the sequence number listed below are applicable to this order. Also shown are data applicable to this order.

<u>Seq Nr</u>	<u>Block 10</u>	<u>Block 11</u>	<u>Block 12</u>	<u>Block 13</u>	<u>Block 14</u>
4	One/R	84 Apr 15	84 Jun 01	84 Sep 01	*

* A minimum of two draft reports will be required. After incorporating Air Force comments concerning the first draft report, the contractor shall supply the USAF OEHL with a second draft report. The report will be forwarded to the applicable regulatory agencies for their comments. The contractor shall supply the USAF OEHL with 20 copies of each draft report, and 50 copies plus the original camera ready copy of the final report.

APPENDIX C
BIOSKETCHES OF KEY PERSONNEL

RICHARD W. GREILING

EDUCATION

University of Wisconsin, B.S., Industrial Engineering (1973)
University of Wisconsin, M.S., Sanitary Engineering (1975)
University of Wisconsin, M.S., Water Resources Management (1975)
University of Washington, Cold Regions Engineering (1980)

PROFESSIONAL ENGINEERING REGISTRATION

Alaska (CE-4940), Arkansas (CE-5794), Nevada (CE-6569), Washington (CE-17737),
and Wisconsin (CE-18130)

PROFESSIONAL EXPERIENCE

Project Manager for site investigations in Phase II of the Installation Restoration Program (IRP) at McChord Air Force Base, Washington. To date the project has resulted in the siting and development of more than 30 groundwater monitoring wells placed at depths up to 250 feet. Geophysical studies have incorporated more than 22,000 linear feet of seismic refraction transects and more than 25 electrical resistivity stations to assist in the geologic interpretation of subterranean impermeable features which may serve as an aquitard between two shallow aquifers, both of which are used for AFB water supply and for public and private water supply in communities adjacent to the AFB. Investigations are continuing to determine the origins of now confirmed hydrocarbon and chemical contaminants, pollutant mobilization and fate, and methodologies to recover or treat the contaminants from the groundwater and the soils.

Project Manager for the performance of RCRA Section 3012 preliminary assessments at 160 potential hazardous waste disposal sites in Washington State. The project entails the records search of local, state and federal regulatory and resource management agencies, on-site surveys, and interviews of owner/operators and adjacent property owners for the purposes of identifying the potential risks associated with past and current hazardous waste management practices, pollutant mobilization and migration, and environmental and health risks. Hazard ranking scores are being developed for numerical rating of all sites, and all site information is being assembled and stored in a computerized data base.

Project Manager for IRP Phase II site investigations at Kingsley Field, Oregon and George AFB, California. Field investigations include magnetometer surveys across abandoned landfills to determine the location and areal extent of suspected buried chemical wastes in steel drums, boring and development of groundwater monitoring wells, soil and groundwater chemical characterization, and the testing for exfiltration of industrial waste and flight-line run-off into the groundwater through a 1.5 mile perforated corrugated metal interceptor and drain line.

RICHARD W. GREILING
Page 2 of 2

Project Manager for the IRP Phase I Records Search at Shemya AFB Alaska, Fairchild AFB, Washington, and Malmstrom AFB, Montana, and the Principal Investigator for the field confirmation and reparation of Phase IIa Presurvey Reports for Clear AFS, Alaska and McChord AFB, Washington. The projects included site survey of all hazardous waste disposal practices; examination of the storage, transfer, use, and disposal of aviation fuels, solvents, lubricants, and other petroleum products; and a technical project work assignment and cost estimate to conduct intensive site investigations.

Analyzed 30 years of precipitation data to generate storm frequencies and rainfall intensities to develop design criteria for run-off control measures at a state-owned, contractor-operated secure hazardous waste landfill in accordance with RCRA regulation 264.301.

Served as Project Manager in a feasibility analysis and impact assessment for long-term disposal strategies for hazardous wastes in the State of Alaska. The study includes integrating treatment, storage and disposal (TSD) information from RCRA permit applicants, and small generator data from an industrial inventory and survey with historical data on abandoned waste disposal sites across the state. Socio-economic and legal considerations, as well as site location and design criteria, are being prepared.

PROFESSIONAL AFFILIATIONS

American Water Resources Association
American Water Works Association
Pacific Northwest Pollution Control Association
Water Pollution Control Federation

PUBLICATIONS

Evaluation of Collection, Treatment and Disposal Alternatives for Hazardous Wastes for the State of Alaska. A report prepared for the Alaska Dept. of Environmental Conservation, Juneau, Alaska, by JRB Associates under subcontract to Resource Technology Corporation, 1982.

Analysis of Precipitation and Development of Hydrologic Responses at the Arlington, Oregon Pollution Control Center. A report prepared for Chem-Securities Systems, Inc., under subcontract to Hart-Crowser Associates, by JRB Associates, 1983.

Geohydrologic Evaluations and Chemical Investigations for McChord AFB Washington. A report prepared for the USAF Occupational and Environmental Health Laboratory for Phase II of the IRP project, Brooks AFB, Texas. R.W. Greiling and S.P. Pavlou, by JRB Associates, 1983.

Implementation of RCRA Section 3012 at 160 Hazardous Waste Sites in Washington State, an invited paper for the Hazardous Materials Control Research Institute Fifth Annual Conference, November 9, 1984, Washington D.C. P.M. O'Flaherty, R.W. Greiling, and B.J. Morson.

PATRICIA M. O'FLAHERTY

EDUCATION

University of Michigan: B.S., Natural Resources - Wildlife (1974)
Kent State University, Ohio: B.S., Biology - Natural Resources (1975)
University of Washington: 12 hours towards M.S., School of Forest Resources

PROFESSIONAL EXPERIENCE

Ms. O'Flaherty is a wildlife biologist with primary experience in areas of water quality monitoring and impacts assessments, hazardous wastes, and fisheries and avian biology.

Currently, Ms. O'Flaherty is a Task Leader of a preliminary assessment team conducting assessments of 160 Washington State hazardous waste storage or disposal sites in accordance with Section 3012 of the Resource Conservation and Recovery Act (RCRA). The preliminary assessment teams assemble and summarize all data relevant to each site as well as perform any site inspections needed to support such data. Factors including ground and surface water characteristics, the nature and quantities of waste material, condition and containment of these materials, potential or real impacts posed by the facility, and an assessment of the magnitude of such impacts are summarized and ranked using the Hazardous Ranking System (HRS) for each site. Ms. O'Flaherty is responsible for determining the completeness of each site she reviews as well as conducting any required field reconnaissance necessary to supplement existing file data. She provides all summarization of site materials and is responsible for the draft and final report segments relevant to these sites.

Ms. O'Flaherty was a Team Leader for IRP Phase I Records Search and Site Investigation at Shemya AFB, Alaska, and Malmstrom AFB, Montana. The projects entailed records search of sites on the installation and at appropriate federal and state offices, interviews of key personnel, and field reconnaissance of the installation of all hazardous waste disposal practices, storage locations, and transfer sites. Site surveys included intensive examination of the POL system, landfill and prior dump sites, and base shops and power plant sites.

She recently completed a water quality monitoring program at several trout hatcheries located in Idaho for EPA Region X. The project is a two-phased study; the first, completed last year, investigated discharges from as many as nine hatcheries in order to provide EPA with data to develop effluent discharge limitations. This was accomplished by a six week field investigation in which she participated collecting water samples for laboratory analyses and conducting in-stream surveys. Following the field study she used results from the JRB study, an industry sponsored study, and historical or relevant literature on fish culturing in order to develop the effluent criteria. Ms. O'Flaherty designed the second phase of this project which is a field examination of instream screening devices to determine their effectiveness in attaining the recommended effluent limits. Ms. O'Flaherty supervised the field staff and hatcheries participating in this phase.

ROBERT L. PESHKIN

Page 2 of 2

Self employed geologist providing interpretive services at oil and gas exploration drill sites. Examined and analyzed rock cuttings for hydrocarbon content through a series of physical and chemical field techniques. Supervised and instructed junior geologists in hydrocarbon detection and analysis. Prepared stratigraphic sections and cuttings logs. Correlated geophysical logs with cuttings logs to determine upper and lower limits of permeable or producing formations.

Research scientist aboard R/V Eastward involved in a marine geochemical paleoclimatic study. Mr. Peshkin was responsible for deep marine sediment collection and analyses of sediment physical/chemical properties, and collection and interpretation of geophysical data. He interpreted paleoclimatic events through correlation of carbonate content of sediments and seismic reflection data.

Computer operator and monitor for a financial data processing firm. Technical responsibilities incorporated a variety of data base management skills such as data entry and retrieval, data sorting, creation of files, daily updating of data files, and data and file transfers. Also responsible for daily microcomputer maintenance and troubleshooting.

Hydroacoustic technician for a fisheries consulting firm involved in a downstream salmonid migration study at five dams on the Columbia River, Washington. Operated and monitored hydroacoustic systems in an effort to count downstream migrants as they passed through the dams. Interpreted and analyzed raw data for entry into computer files. Computer oriented tasks included creation of data files; retrieval, interpretation and sorting of data; and editing of files through the use of word processing skills.

PUBLICATIONS

"Carbonate Dissolution in the Western North Atlantic: Glacial/Interglacial Changes on the Muir and Siboney Seamounts." Co-author. Abstract published by The Geological Society of America. March, 1980.

MICHAEL L. FEVES

EDUCATION

Reed College: B.A., Physics

Massachusetts Institute of Technology: Ph.D., Geophysics

PROFESSIONAL EXPERIENCE

1978 to Present: Senior Research Geophysicist, Foundation Sciences, Inc.

Dr. Feves is responsible for conducting geophysical surveys for FSI. He recently completed a seismic refraction and electrical resistivity survey at McChord AFB, Washington and Kingsley Field, Oregon. The purpose of these studies was to help assess the local hydrology and water quality. In the past several years Dr. Feves has conducted numerous P and S wave seismic studies. He is experienced with cross-hole and surface refraction techniques. The purpose of many of these studies was to determine the dynamic moduli of rocks in situ. At Mt. St. Helens, Washington downhole seismic techniques were used to help assess the stability of the Spirit Lake debris dam.

Dr. Feves has also been responsible for conducting several vibration monitoring studies in the Pacific Northwest. In these studies the ground vibrations caused by such activities as blasting, pile driving, and commercial traffic were monitored and ground response spectra were determined.

Dr. Feves has also been responsible for several of FSI's laboratory and in situ rock testing programs. He was the project manager for a laboratory testing program to completely characterize the thermal and mechanical properties of basalt. This testing, which was conducted in the FSI rock mechanics laboratory for Rockwell Hanford Operations, evaluated such properties as uniaxial and triaxial compressive strength, dynamic and elastic constants, thermal expansion, and conductivity, among others.

At the Near-Surface Test Facility on the Hanford Site near Richland, Washington, Dr. Feves participated in training technicians to install a system of rock instrumentation. The instruments, which include borehole deformation gages, vibrating wire stressmeters, extensometers and thermocouple assemblies, will measure deformation and increasing temperature of the surrounding basalt in a simulated nuclear waste repository.

Subsequently, Dr. Feves acted as a Team Leader, supervising the actual installation of the instruments. Dr. Feves gained an intimate knowledge of the behavioral characteristics of the instruments while acting as Test Supervisor during a year-long program of laboratory testing prior to installation. This program was conducted to analyze the long-term stability and electronic drift characteristics of the instruments, and to better understand the gage-rock interaction of vibrating wire stressmeters and borehole deformation gages at elevated temperatures.

1981 to Present: Adjunct Professor, Portland State University

Courses Taught: Quantitative Evaluation of Geologic Hazards, Rock Mechanics.

MICHAEL L. FEVES

Page 2 of 2

1984 to Present: Adjunct Professor, University of Portland

Courses Taught: Physics for Non-Majors

1977 to 1978: Research Engineer, Dowell Division, Dow Chemical Company, Tulsa, Oklahoma

Dr. Feves was responsible for supervising construction and operation of a new lab to study relationships between rock properties and hydraulic fracturing.

PUBLICATIONS

"Determination of the Thermal History of Bronzite Using the Mossbauer Effect", B.A. Thesis, 1973.

"Effects of stress induced cracks and saturation on V_p", (Abstract) EOS Trans. AGU, 55, 1974. (co-author)

"Differential Strain Analysis: a New Method for Examining Cracks in Rocks", J. Geophys. Res., 79, 1974. (co-author)

"Stress induced cracks in Westerley granite", (Abstract) EOS Trans. AGU, 56, 1975. (co-author)

"Microcracks in ancient rocks", (Abstract) EOS Trans. AGU, 57, 1976. (co-author)

"Effects of stress on cracks in Westerley granite", Bull. Seismo. Soc., Am., 66, 1976. (co-author)

"Microcracks in crustal igneous rocks: physical properties", Proc. Symp. on Nature of the Crust, Vail, Colo., AGU monograph, 1977. (co-author)

"The relationship of microcracks to in situ stress in Southeastern Missouri", (Abstract) Geol. Soc. Am., 8, No. 6, 1976. (co-author)

Characterization of stress-induced cracks in rocks, MIT Ph.D. thesis, 1977.

"Characterization of microcracks", (Abstract) Proc. Conf. Mechanisms of Deformation and Fracture, 1978. (co-author)

"Effects of coring on microstructure of Cotton Valley Sandstone" Proc. 20th U.S. Symp. on Rock Mechanics, Austin, Texas, 1979. (co-author)

"Microstructural damage in Cotton Valley Fm. cores", Proc. 54th Annual Technical Conference and Exhibition, Soc. of Petroleum Engineers, Paper No. 8303, Las Vegas, Nevada, 1979. (co-author)

"Elastic properties and compressive strength of unjointed specimens of Pomona Basalt," (Abstract) EOC Trans. AGU, 61, 1980. (co-author)

"Design, fabrication and testing of a rock instrumentation system for monitoring the thermal-mechanical response of basalt," Bull. Assoc. of Eng. Geol., 1981. (co-author)

APPENDIX D
BORING LOGS AND SOIL CLASSIFICATION INDEX

JRJB ASSOCIATES

— BORING LOG —

PROJECT: Kingsley Field IRP, Phase II LOCATION: Klamath Falls, Oregon

WELL ID: K201 DATE: 17 September 1983

SURFACE ELEVATION:

GROUNDWATER ELEVATION:

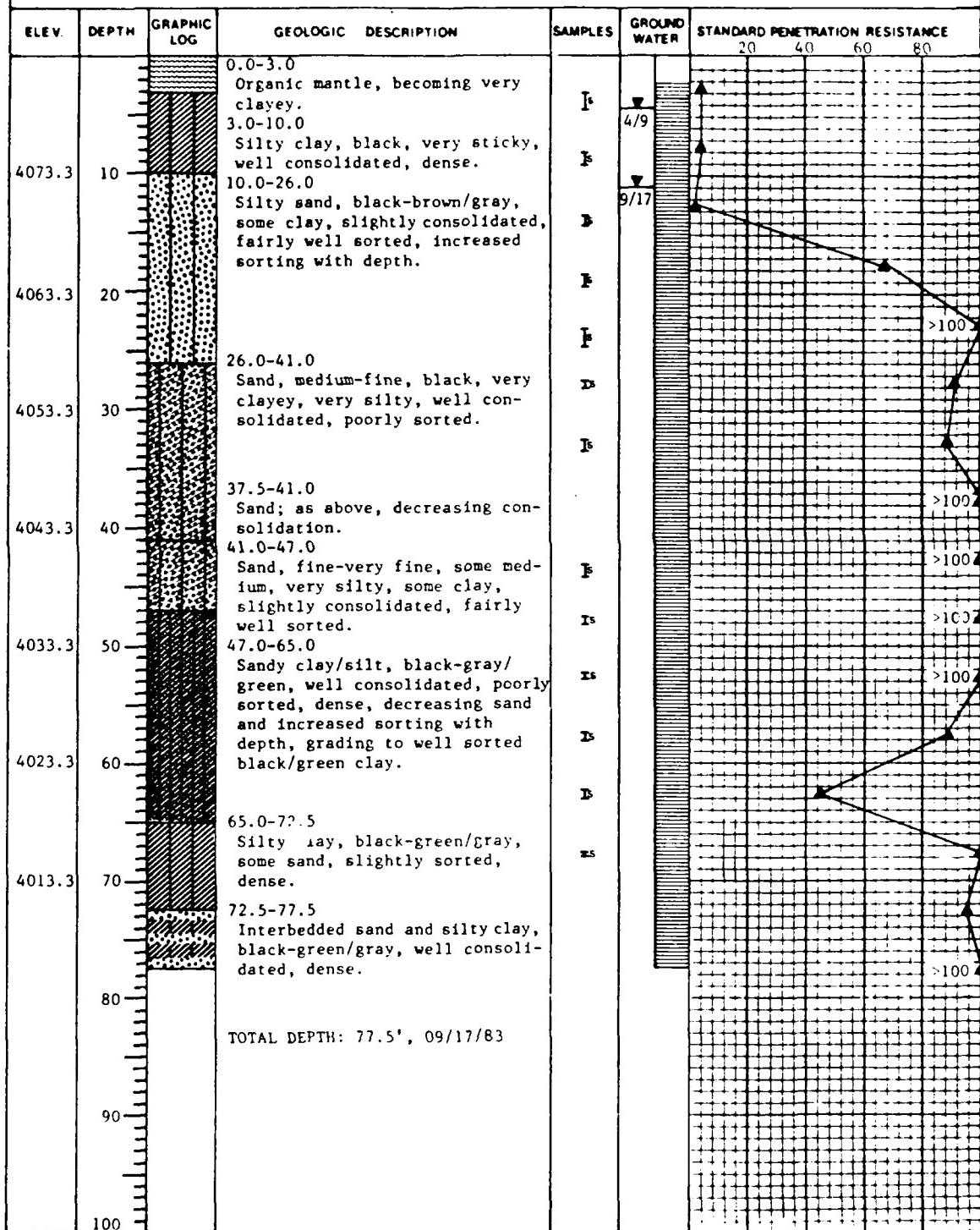


Table D-1
GUIDELINES FOR CLASSIFICATION OF SOILS

Cohesionless (Sands & Gravels)		Cohesive (Silts & Clays)		
N-Blows/ft ^a	Relative Density	C, tsf ^b	N. Blows/ft ^a	Relative Consistency
0-4	Very loose	0.125	2	Very soft
4-10	Loose	0.125-0.25	2-4	Soft
10-30	Medium	0.25-0.50	4-8	Medium
30-50	Dense	0.50-1.0	8-15	Stiff
50	Very dense	1.0-2.0	15-30	Very stiff
		2.0	30	Hard

<u>Grain Size Classification</u>		<u>Sensitivity^c</u>	
12"-36"	Boulders	Low	2
3"-12"	Cobbles	Normal	2-4
No. 4-3"	Gravel	Sensitive	4-8
3/4"-3"	Coarse	Extra Sensitive	8-16
No. 4-3/4"	Fine	Super Sensitive	16
No. 200-No. 4	Sand		
	No. 10-4 Coarse		
	No. 40-10 Medium		
	No. 200-40 Fine		

Modifier for Subclassification

<u>Percent^d</u>	
0-1.5	Clean
1.5-10	Trace
10-30	Some
30-50	Sandy, silty, or clayey

^aBlows per foot standard penetration test

^bC - Shear strength (measured in unconfine compression or Torvane test).

^c $\frac{q_u \text{ undisturbed}}{q_u \text{ remolded}} = \text{Sensitivity}$

^dPercentage of dry weight of total sample

Project: Kingsley Field 1RP, Phase II Well ID: KZ01

DRILLING SUMMARY

Total Depth: 77.5'

Borehole Diameter: 8"

ELEVATION:

Land Surface: 4083.25

Top of Casing: 4086.25

Groundwater: 4072.25

Drilling Started: 17 Sept 83 (date) 0900 (time)

Geologist: Robert Peshkin

NOTES:

Driller: Jim Clarke

Subterranean, Inc.

Sumner, WA

Rig Type: Mobile, B-61

Bit(s): Carbide Tooth

Drilling Fluid: None

Drilling Completed: 17 Sept 83 (date) 1730 (time)

Technician:

WELL DESIGN

BLANK CASING

Material: PVC

Diameter: 2.0" ID 2.375" OD

Depth: 0.0' - 2.5'

SEALS: Type: Threaded

Filter Material: Backfill Sand Cuttings

Surface Monument: 48" x 6" I.D. Steel Pipe with Locking Cover

NOTES:

SLOTTED CASING

Material: PVC

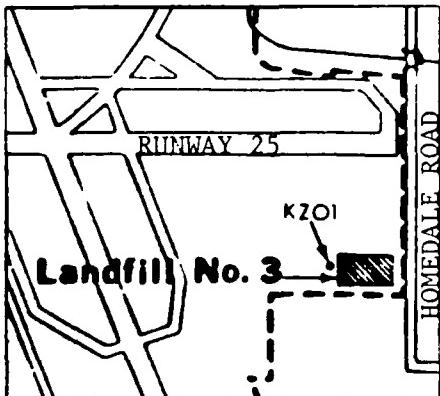
Diameter: 2.0" ID 2.375" OD

Depth: 2.5' - 77.5'

SEALS: Type: Threaded

GROUT: Type: Bentonite/Cement

SITE DESCRIPTION



Site Sketch

Location: Southeast Corner of Kingsley Field, West of Landfill No. 3, South of Runway 25.

Latitude: _____ Longitude: _____

Twp: 39S Rge: 9E Sec: N¹/₂ NE¹/₄ 26

Project: Kingsley Field IRP, Phase II Well ID: KZ02**DRILLING SUMMARY**Total Depth: Borehole - 77.5'; Well - 68'Borehole Diameter: 8"**ELEVATION:**Land Surface: 4082.08Top of Casing: 4085.08Groundwater: 4078.58Drilling Started: 18 Sept 83
(date) 0800
(time)Geologist: Robert Peshkin

NOTES: _____

Driller: Jim Clarke

Subterranean, Inc.

Sumner, WA

Rig Type: Mobile B-61Bit(s): Paddle ToothDrilling Fluid: NoneDrilling Completed: 18 Sept 83
(date) 1530
(time)

Technician: _____

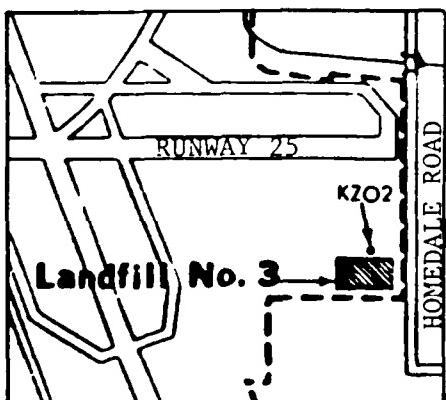
WELL DESIGN**BLANK CASING**

Material: _____

Diameter: _____ ID _____ OD

Depth: _____

SEALS: Type: _____

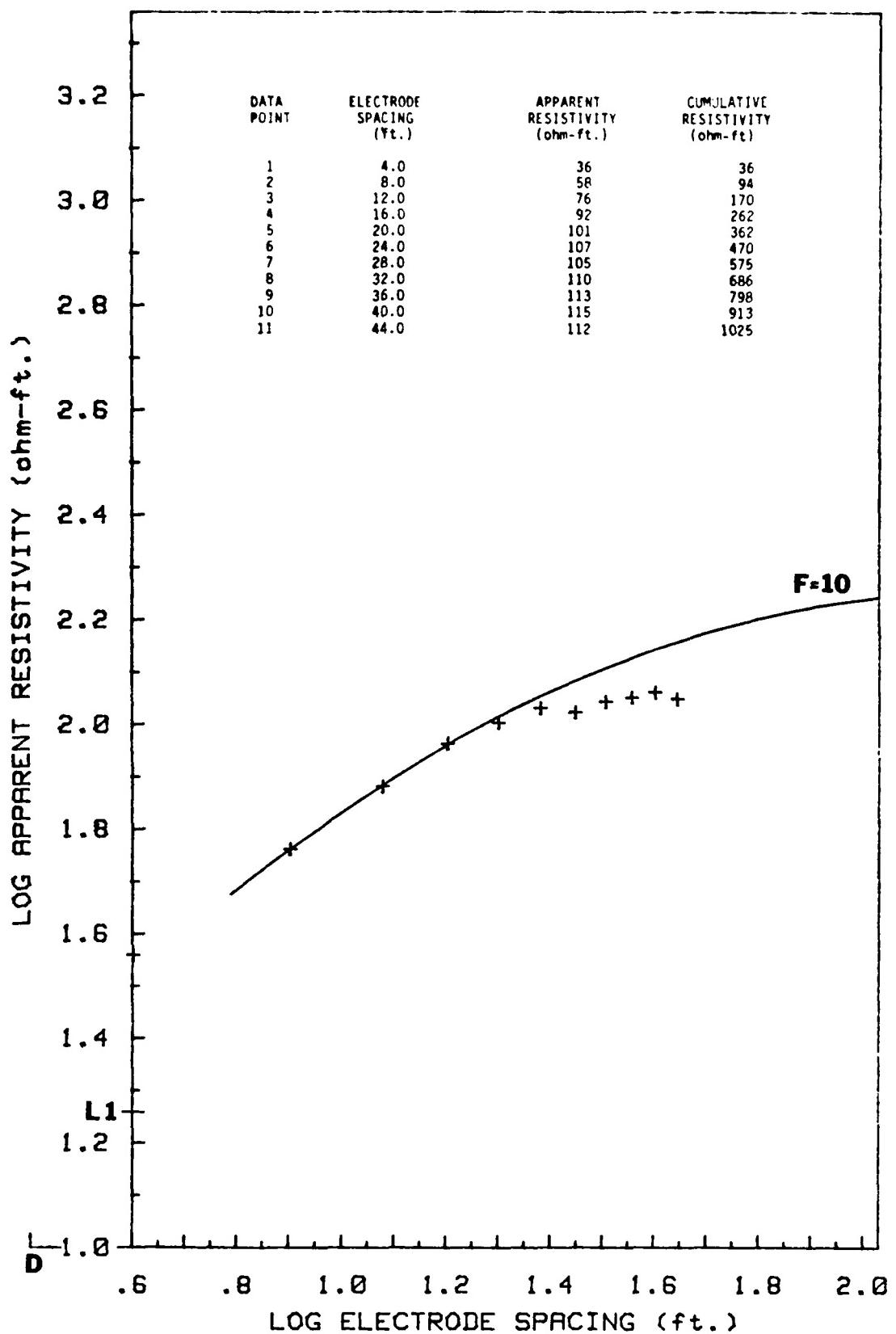
Filter Material: Backfilled Sand CuttingsSurface Monument: 48" x 6" I.D. Steel Pipe with Locking CoverNOTES: Slotted pipe used from surface to total depth because 10' of blank pipe
removed when casing was accidentally pulled up during development.**SLOTTED CASING**Material: PVCDiameter: 2.0" ID 2.375" ODDepth: 0.0' - 68.0'SEALS: Type: ThreadedGROUT: Type: Bentonite/Cement**SITE DESCRIPTION**Location: Southeast Corner of Kingsley Field, North of Landfill No. 3, South of Runway 25.

Latitude: _____ Longitude: _____

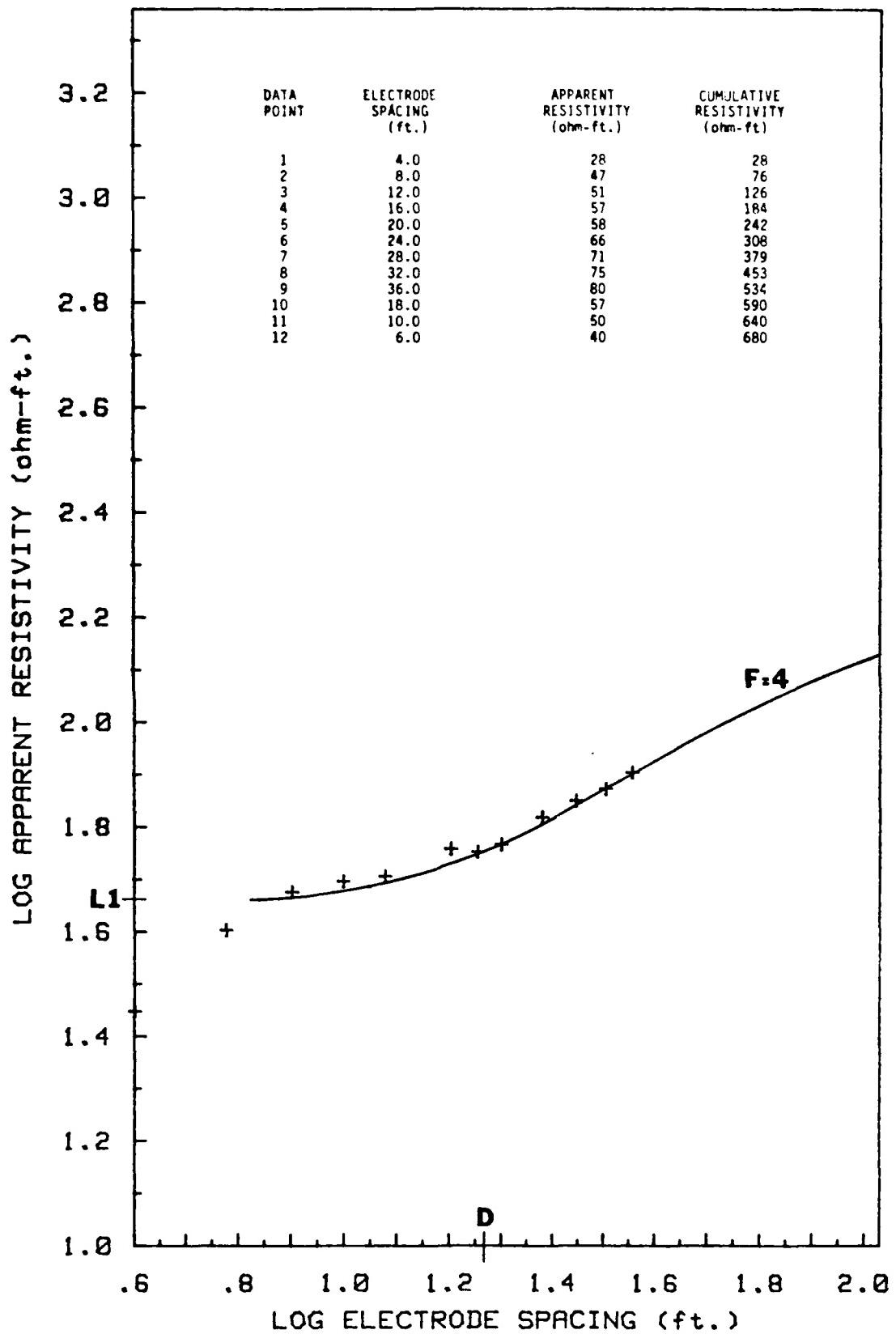
Twp: 39S Rge: 9E Sec: N $\frac{1}{2}$ NE $\frac{1}{4}$ 26

APPENDIX E

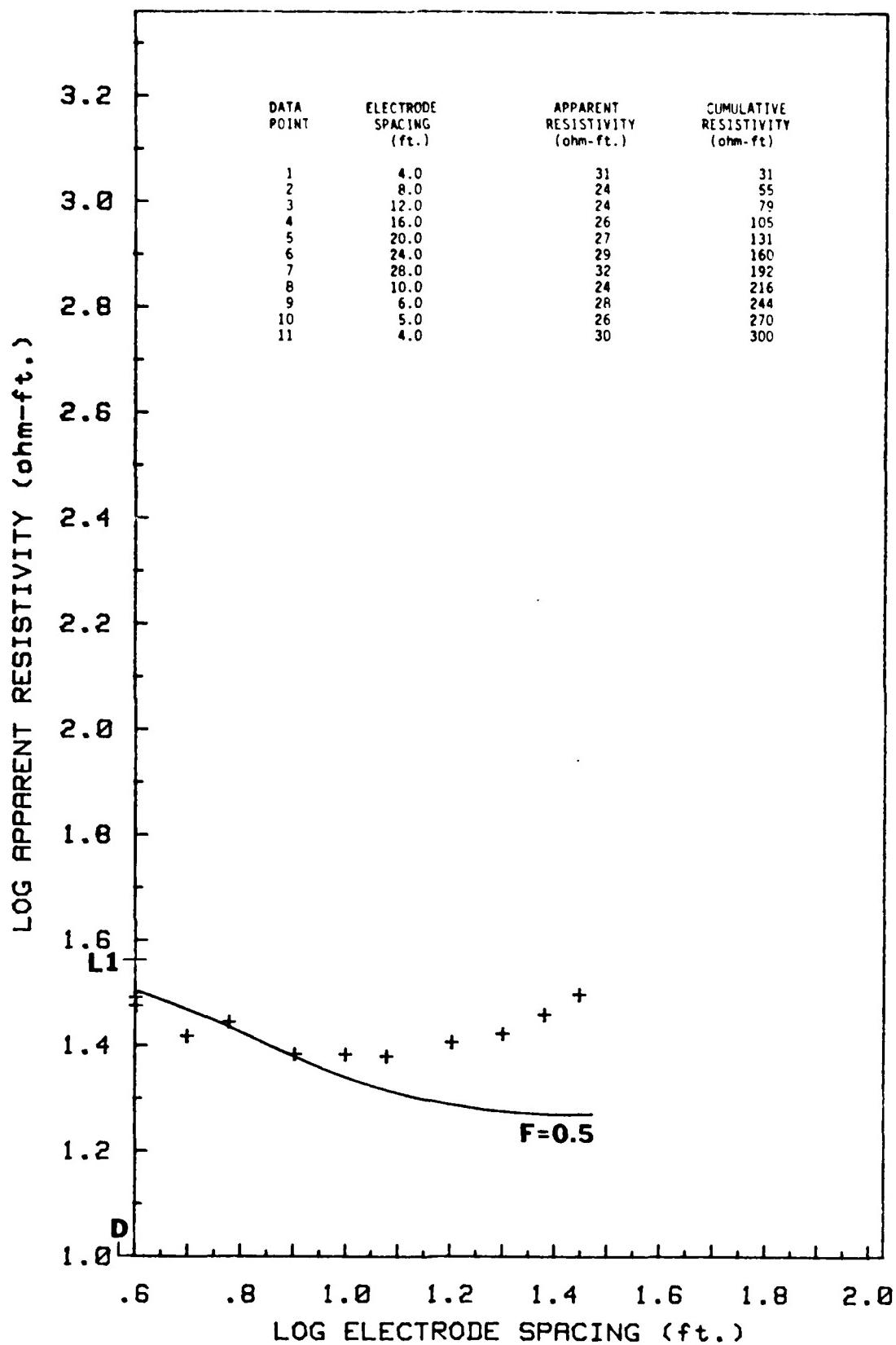
**ELECTRICAL RESISTANCE LOGS AND TRACINGS FROM THE
GEOPHYSICAL SURVEY PERFORMED AT LANDFILL NO. 3**

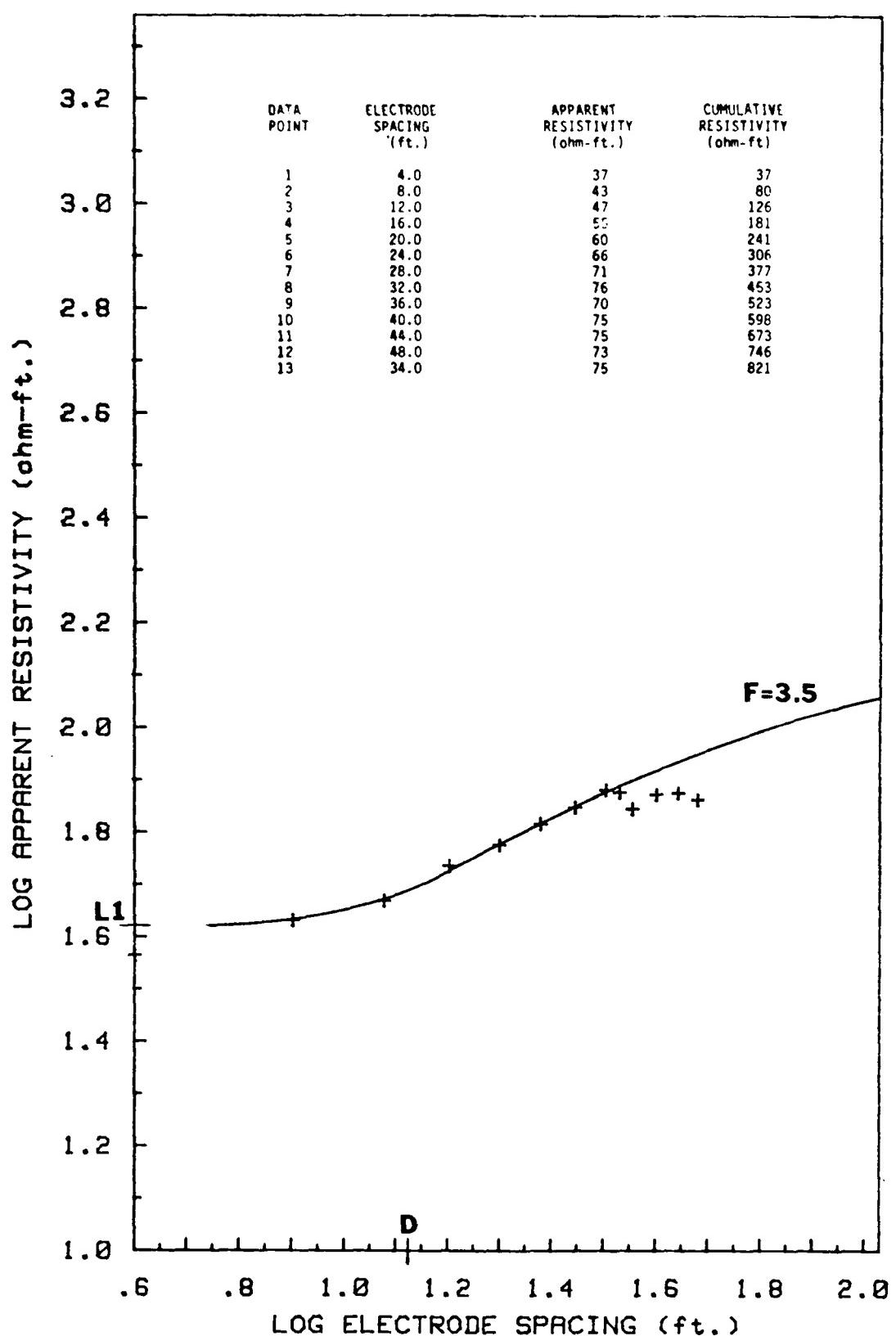


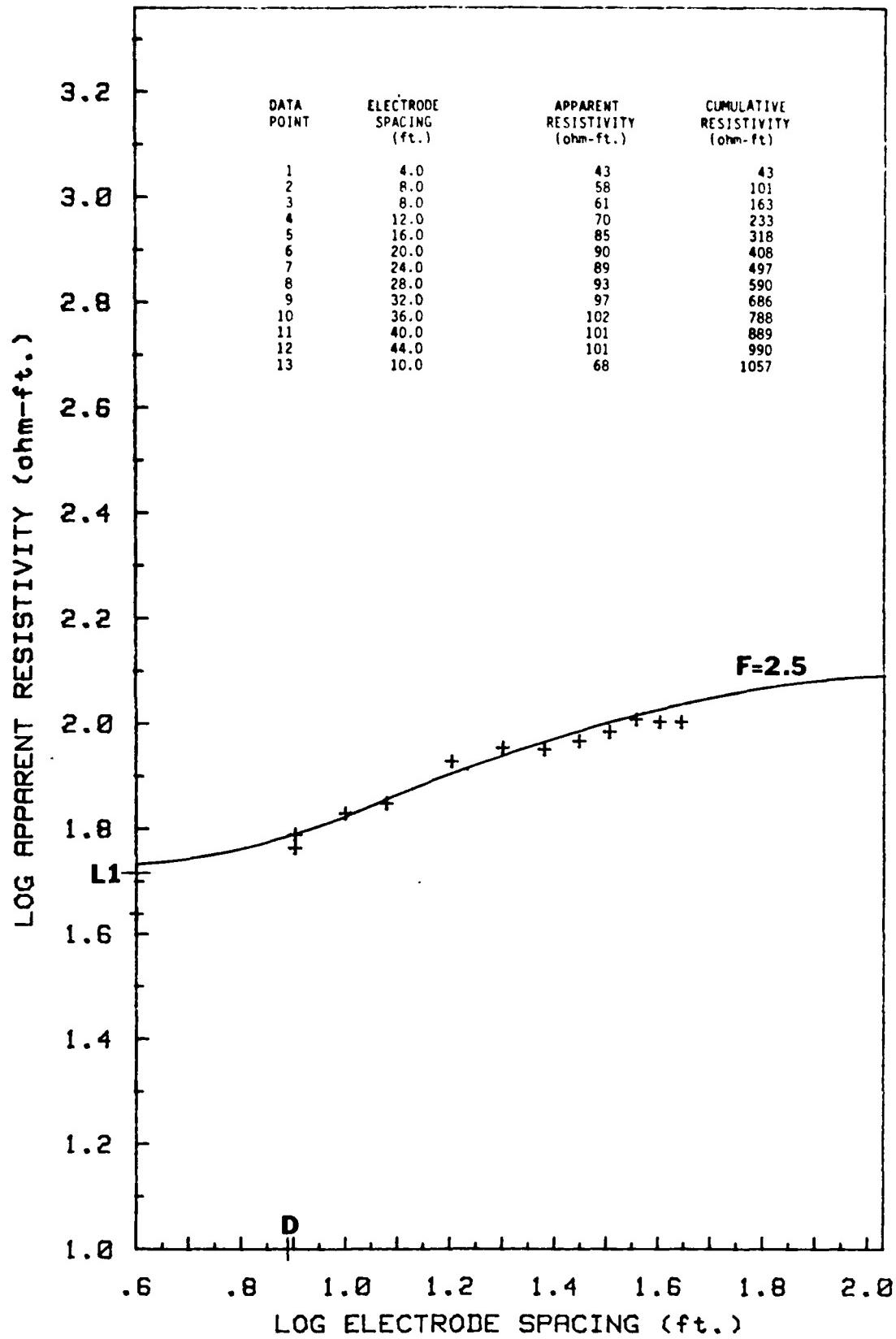
STATION No. 1



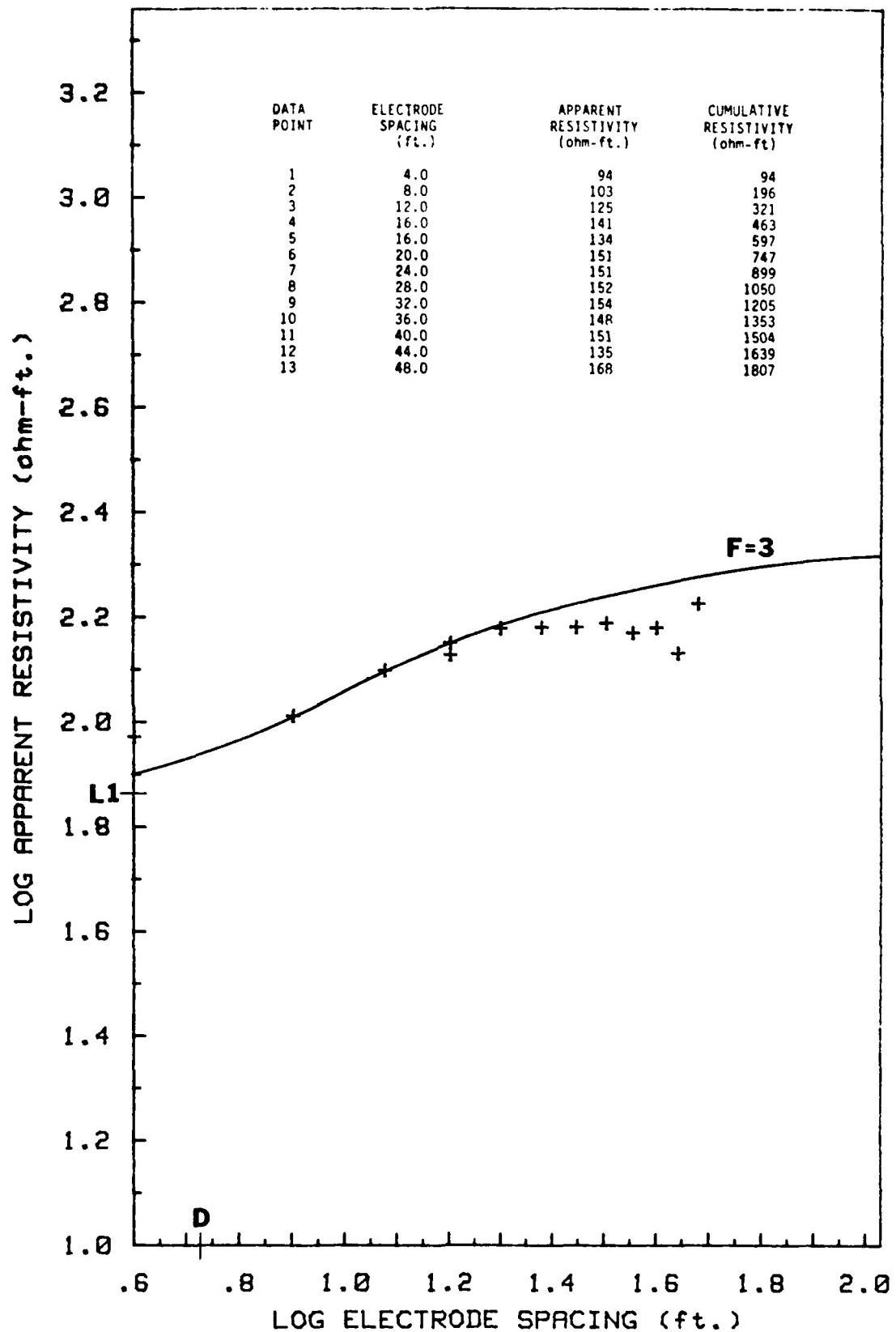
STATION No. 2

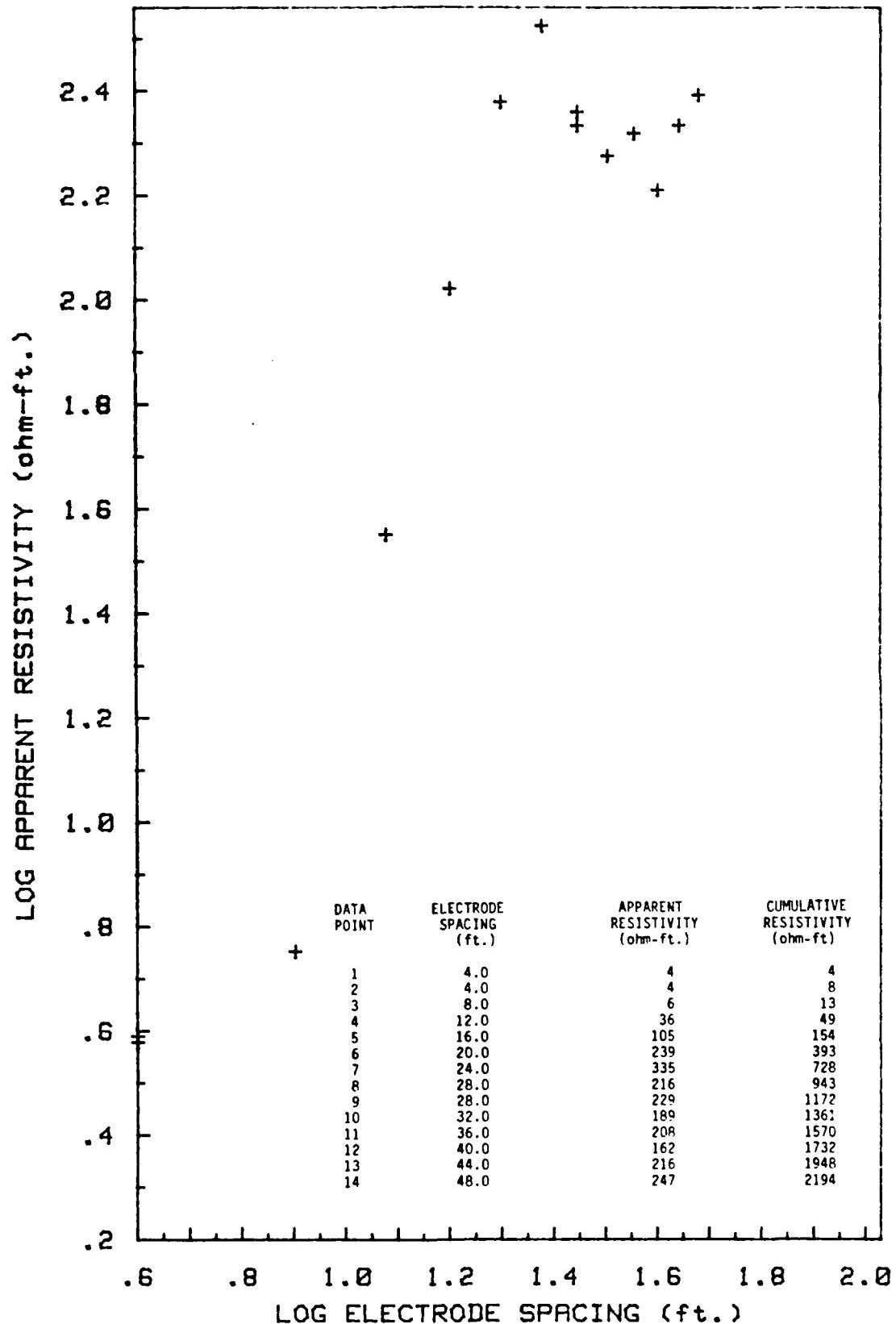






STATION No. 5





STATION No. 7

APPENDIX F
SAMPLE CHAIN OF CUSTODY PROTOCOL

1.0 FIELD SAMPLE CUSTODY

Chain of custody procedures were employed with all collected groundwater samples in the project. An example of the chain of custody form currently being used by JRB is shown in Figure F-1. The procedures are straight forward and follow common sense rules. A brief summary of the salient features is presented below.

When the sample was initially taken, it was logged, identified, and labeled. This included at least the site, depth of sample, sample type, date, time, and sampling person. The field sampling person has primary responsibility for proper maintenance of the sample in the field. When the samples were shipped to the laboratory, JRB prepared and packed all samples in ice, sealed the coolers, and transferred the samples to the airline freight forwarding company. Signatures of the freight personnel at each shipping or transfer point were required. When the sample arrived at the lab, designated personnel received the samples, asked the delivery person for a sign off on the condition of the shipment, and then began the preparation process for each sample until analysis. Upon receipt at the lab all samples were logged into the laboratory chain of custody and tracking system.

Once the samples have been analyzed, any remaining unanalyzed sample aliquots are kept in the laboratory tracking system until the end of the project. Final extracts or solutions used in the analytical process are also logged into the tracking system and stored in controlled access freezers and coolers throughout the life of the project. At the end of the project, JRB will seek instructions from the USAF on the final disposition of the samples. If after 120 days from the end date of the project instructions have not been received, JRB will dispose of the samples in an appropriate manner.

2.0 LABORATORY SAMPLE CUSTODY

Sample custody is maintained at JRB's analytical laboratory through the use of several tracking systems designed to protect sample integrity. Mechanisms utilized to ensure sample integrity include formal chain of custody documentation, locked sample storage, analysis request forms, and routine sample status review by laboratory and program managers.

For programs not requiring field collection by JRB personnel, the sample tracking system will be initiated immediately upon receipt at JRB's analytical facility. An overview of the sample tracking and chain of custody procedure to be used is presented in the flow diagram illustrated in Figure F-2. This procedure includes the following components:

1. Upon arrival all samples are inspected to insure that each sample is intact. This inspection will include examination of sample seals (when stringent chain of custody is required) and anomalies are noted in the JRB sample log book, chain of custody form and the client is alerted.

JRB ASSOCIATES			SAMPLE CHAIN OF CUSTODY LOG			Shipment No. _____		
Project: _____						Reason for Transfer: _____		
Sampling Date	Start Time	Station ID	SEQ No.	R-Rep B-Blk S-Sam	Matrix/Media	# Items/ Containers	Remarks	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
Column Total:								
Signature/Affiliation PLEASE	Relinquished by:		Shipping Method:		Date/Time:	Condition		
	Received by Courier: TIME		Received by Shipping Company:		Date/Time:	Condition		
	Courier from Shipping Company:				Date/Time:	Condition		
	Received by Lab:				Date/Time	Condition		
	JB Associates 13400-B Northup Way Suite 38 Bellevue, Washington 98005 (206) 747-7899							
Copy 1 - Return to Original Sampler Copy 2 - Laboratory Record Copy 3 - Original Sampler								

Figure F-1

EXAMPLE OF JRB CHAIN OF CUSTODY LOG

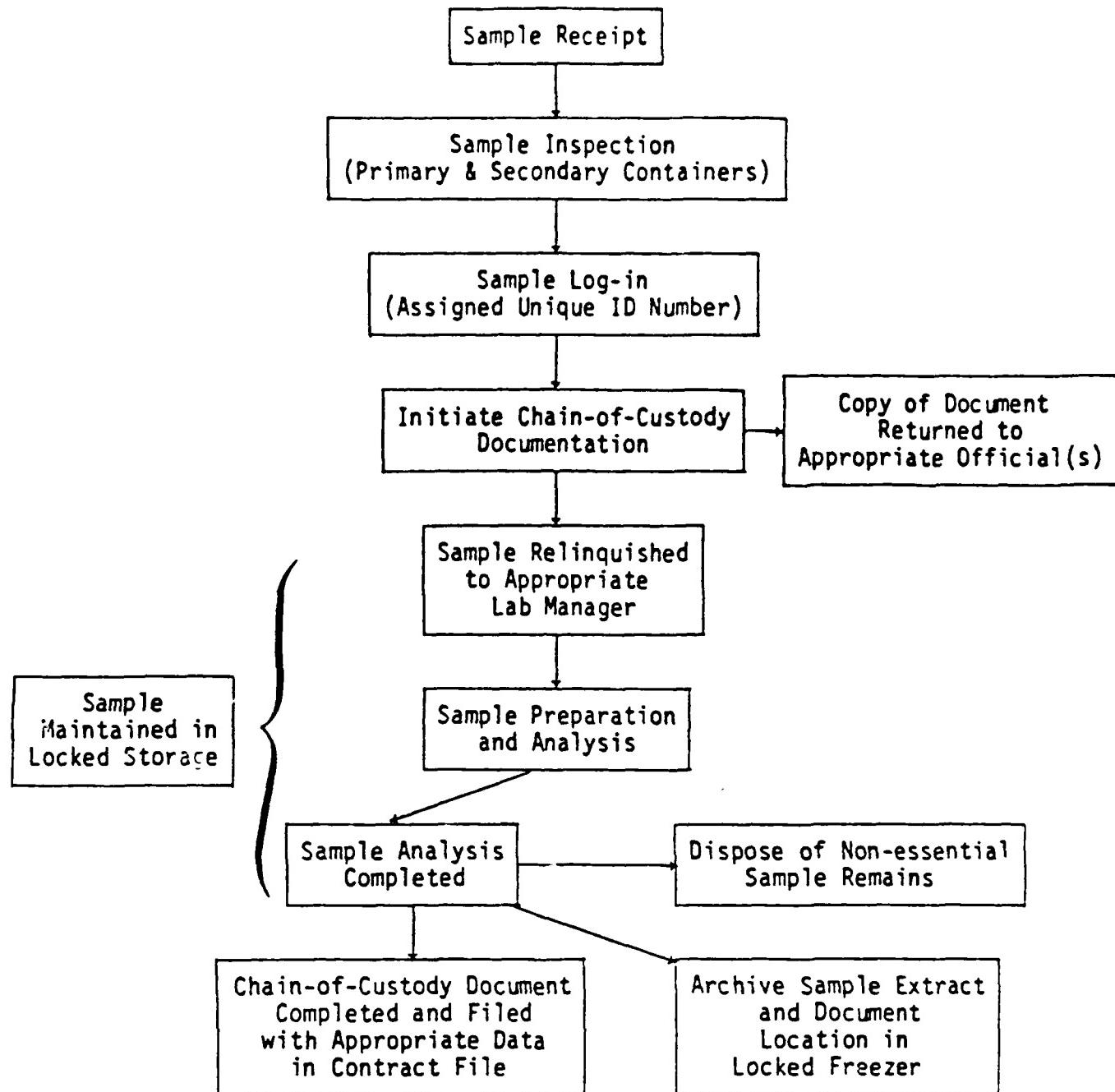


Figure F-2
CHAIN OF CUSTODY/SAMPLE TRACKING FLOW DIAGRAM

2. Each sample is assigned a unique JRB sample identification number (cross-coded with the project's field numbering). Sample identification information is kept in a bound log book and this ID number is used to track sample location and status throughout the analytical facility.
3. When formal chain of custody is required, the chain of custody document is initiated when the sample is relinquished by the courier to the laboratory for analysis.
4. The field chain of custody document is completed and carbon copies are returned to the appropriate party(s).
5. The following information is recorded in the JRB sample log book: sample origin, customer and project information, time and date of receipt, sample type, analysis required, preservatives, and pertinent comments.
6. After the sample is logged in and chain of custody is initiated, an internal chain of custody/tracking document is generated.
7. This internal chain of custody document (Figure F-3) requires that the sample be formally relinquished by one party and accepted by the other at each step of the analytical process. This document accompanies the sample through each step of the analytical process.
8. While within JRB's laboratory, sample integrity is maintained through the use of locked storage areas. Samples remain in locked storage areas except when actively involved in the analytical process.
9. When analytical activities are completed, internal and external chain of custody documents are completed and filed in the appropriate contract file.
10. According to contract requirements, sample remains are either archived in locked storage areas or disposed of properly.
11. A formal record is kept on archived samples until ultimate disposition is determined.

In addition to the external and internal chain of custody documents, analysis request forms (see Figure F-4) are utilized to further control sample flow and facilitate tracking within the analytical facility. Within each functional lab unit, the laboratory manager is responsible for maintaining sample integrity, fulfilling chain of custody requirements, scheduling sample flow, and tracking sample status. These activities are facilitated through the use of the above referenced documents and formal laboratory notebooks.

All laboratory personnel are required to maintain permanent laboratory notebooks which document all activities associated with the analytical process. Laboratory notebooks are the fundamental record of each staff member and are bound pre-numbered volumes. The WA officer assigns these notebooks, stores

Figure F-3

JRB INTERNAL CHAIN OF CUSTODY FORM

ANALYSIS REQUEST FORM

Date Submitted _____ Person Submitting Samples _____
Contract _____ Labor & Analysis Charge No. _____

Standards submitted _____

Do you want these analyses on cassette tape? _____

Spectra or Chromatograms to: _____

Sample remainders to:

Data analyses required _____

Comments or Suggestions: _____

Figure F-4

JRB ANALYSIS REQUEST FORM

full ones, logs location of notebooks and dates of use, and reviews them regularly. Several rules govern the use of these notebooks:

1. Only assigned lab notebooks are used for record-keeping related to project work.
2. All writing must be legible and in ink, and all numbers must be clear. Errors are crossed out with single lines rather than by erasing or over-writing. All entries must be dated.
3. The first one or two pages are left blank for a Table of Contents to be filled in as project tasks are completed.
4. Project goals are included as are plans for achieving them, including specific references, considering that another person might have to write a report with only the information in a notebook. Efforts are made to be as specific as possible, avoiding the assumption that another person who reads a description will understand information that is not available.
5. All relevant information is included (e.g., the manufacturer and lot number of a chemical, the specific procedure used for each sample preparation and analysis, instrumental conditions, etc.).
6. All tables and graphs are labeled clearly and any abbreviations explained. Terms used in equations are defined. No loose papers are included.
7. If any data are determined to be invalid, reasons are indicated.
8. Draw appropriate conclusions following the completion of laboratory experiments, stating reasons for the conclusions.
9. When work is continued in another notebook, the number of the second notebook is written in the first notebook and vice versa.

When each analysis is complete, the analyst will review data relative to correlative QA/QC results and/or make comparisons with other analysts' results on similar samples. The analyst is usually the first to notice unusual results at the individual parameter level (spiked, duplicates, standards, etc.). If any problem is detected, the analyst will consult with the Project Manager and the Division's QA officer regarding needs for retesting or to discuss the use of an alternative procedure.

A second check at the individual parameter level is performed by the investigator responsible for interpreting and/or reporting the results. The chemist checks QA/QC results (control chart adherence, reference samples, blanks, spikes and duplicates) from the raw data and sample results through calculations to the final reported value. If results are unsatisfactory, the analyst is informed and retesting is scheduled (either by the original analyst or a third party analyst) or other means of rectifying the situation are implemented.

Finally, the Division's QA officer reviews the analytical results as a whole from the raw data with emphasis on blanks, precision and accuracy data, significant figures, and the overall "sense" of the results and their interrelationships. Any problems are referred to the analyst and Program Manager for resolution to the satisfaction of the QA officer.

APPENDIX G
GROUNDWATER CHEMICAL DATA

**COMPOUND OF INTEREST AND ANALYTICAL DETECTION
LIMIT AND PROTOCOL EMPLOYED IN PERFORMING
IRP PHASE II AT KINGSLEY AFS, OREGON**

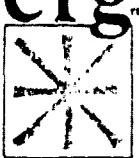
<u>Compound/Element</u>	<u>Detection Limit</u>	<u>Analytical Method</u>
Total Iron	100 µg/l	EPA Method 236.2 ^a
Chloride	1 mg/l	EPA Method 325.1 ^a
Total Organic Carbon	1 mg/l	EPA Method 415.1 ^a
Chemical Oxygen Demand	5 mg/l	EPA Method 410.4 ^a
Oils and Grease (IR Method)	100 µg/l	ASTM, Part 31 ^b
Specific Pesticides		EPA Method 608 ^a
Aldrin	20 ng/l	
DDT Isomer	20 ng/l	
Dieldrin	20 ng/l	
Endrin	20 ng/l	
Heptachlor Epoxide	20 ng/l	
Lindane	10 ng/l	
Methoxychlor	20 ng/l	
Halocarbons, Purgeable	1 µg/l	EPA Method 601 ^c
Aromatics, Purgeable	1 µg/l	EPA Method 602 ^d
Halides by Haloscan	1 µg/l	Interim EPA Method 9022

^aMethods for Chemical Analysis of Water and Wastes, EPA 600/4-79-020 (1979).

^bASTM Methods, Part 31, pp. 72-82 (1976).

^cGas Chromatographic and HPLC Methods for Purgeable Hydrocarbons, 44 FR 69468.

^dGas Chromatographic and HPLC Methods for Purgeable Aromatics, 44 FR 6974.



ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

PROJECT 41098
REPORT DATE 10-09-83

117-1-PILOT
446 APPROVED BY CHIEF AIR 49104 (813) 663-3104

JOHN R. LEE
REPORT NO. 1

SAMPLES RECD: 09-30-83
REFER TECHNICAL QUESTIONS
TO JACK SHEETS

CALIFORNIA
ASSOCIATION INC.
8400 WESTFALL DRIVE
MC LEAN, VA 22102

ATTENTION: CLAUDIA KIEGANO

APPROVED

RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS

CLIENT I.D.: FUMPHOUSE 8028
ERS SAMPLE NO. 10/096585
MATRIX: NATURAL WATER
DATE COLLECTED: 09-26-83

PARAMETER	RESULTS	UNITS
IRON, TOTAL	0.58	mg/L
CHLORIDE	130	mg/L
CARBON, TOTAL ORGANIC	150	mg/L
CHEMICAL OXYGEN DEMAND	1200	mg/L
4-CHLORO-2-CHLOROPHENYL 2,4-DI(2-METHYLPHENYL)-	ND (1.0)	ug/L
2,4-DIMETHYLMETHANE	ND (1.0)	ug/L
BIS(1,1,1,3,3-PENTAFLUORO-1-METHYL-1-PROPYL)METHANE	ND (1.0)	ug/L
DICHLORODIFLUOROMETHANE	ND (1.0)	ug/L
VINYL CHLORIDE	ND (1.0)	ug/L
CHLOROETHYNE	ND (1.0)	ug/L
METHYLENE CHLORIDE	27	ug/L
1,1-DICHLORODIFLUOROMETHANE	ND (1.0)	ug/L
1,1-DICHLOROETHANE, 1,1-	ND (1.0)	ug/L
1,1-DICHLOROETHANE, 1,1-	ND (1.0)	ug/L
TRANS-1,2-DICHLOROETHYLENE	ND (1.0)	ug/L
CHLOROPROPENE	ND (1.0)	ug/L
DICHLOROPETRALENE, 1,2-	ND (1.0)	ug/L
TRICHLOROETHANE, 1,1,1-	ND (1.0)	ug/L
CARBON TETRACHLORIDE	ND (1.0)	ug/L
TRICHLOROETHANE	ND (1.0)	ug/L
1,1-DICHLOROPROPANE, 1,2-	ND (1.0)	ug/L
TRANS-1,2-DICHLOROPROPENE	ND (1.0)	ug/L
TRICHLOROETHYLENE	ND (1.0)	ug/L
1,1-DICHLOROETHANE	ND (1.0)	ug/L
TRICHLOROETHANE, 1,1,2-	ND (1.0)	ug/L
DIS-1,2,3-DICHLOROPROPENE	ND (1.0)	ug/L
2,4-DI(2-METHYLPHENYL)-	ND (1.0)	ug/L
2,4-DI(2-METHYLPHENYL)-	ND (1.0)	ug/L
2,4-DI(2-METHYLPHENYL)-	ND (1.0)	ug/L
2,4-DI(2-METHYLPHENYL) ETHER, 2-	ND (1.0)	ug/L
PERCHLOROETHANE	ND (1.0)	ug/L

PAGE 1 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

CONTINUED



ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

14. PROJECT NO. A1355 - AG ASSOCIATES, INC.

12-05-83

CLIENT ID: 8028
 ERG SAMPLE NO: 10/096596
 MATRIX: NATURAL WATER
 DATE COLLECTED: 09-26-83

PARAMETER	RESULTS	UNITS
TETRACHLOROETHANE 1,1,2,2-	ND (1.0)	ug/L
TETRACHLOROETHYLENE	ND (1.0)	ug/L
CHLOROBENZENE	ND (1.0)	ug/L
DICHLOROBENZENE 1,3-	ND (1.0)	ug/L
DICHLOROBENZENE 1,2-	ND (1.0)	ug/L
DICHLOROBENZENE 1,4-	ND (1.0)	ug/L
FURCABLE AROMATICS		
BENZENE	ND (1.0)	ug/L
1,2-DICHLOROBENZENE	ND (1.0)	ug/L
1,3-DICHLOROBENZENE	ND (1.0)	ug/L
1,4-DICHLOROBENZENE	ND (1.0)	ug/L
ETHYL BENZENE	ND (1.0)	ug/L
TOLUENE	ND (1.0)	ug/L
CHLOROBENZENE	ND (0.10)	ug/L
ALDRIN	ND (0.10)	ug/L
DIELDRIN	ND (0.10)	ug/L
ENDRIN	ND (0.10)	ug/L
HEXACHLOROBUTADIENE (CLIPANE)	ND (0.10)	ug/L
HEPTACHLOR	ND (0.50)	ug/L
DDD, P,P'	ND (0.10)	ug/L
DDT, P,P'	ND (0.10)	ug/L
DDT, P,P'	ND (0.10)	ug/L
HEPTACHLOR EPOXIDE	ND (0.10)	ug/L
OIL AND GREASE BY IR	5.8	ug/L

CLIENT ID: 8028 9-501
 ERG SAMPLE NO: 10/096596
 MATRIX: NATURAL WATER
 DATE COLLECTED: 09-26-83

PARAMETER	RESULTS	UNITS
IRON, TOTAL	150	ug/L
CH. CHLORIDE	150	ug/L
CARBON, TOTAL ORGANIC	12	ug/L
CHEMICAL OXYGEN DEMAND	140	ug/L
FLUORIDES, EDI	ND (1.0)	ug/L
CHLOROMETHANE	ND (1.0)	ug/L
BRONCHETHENE	ND (1.0)	ug/L
DICHLORODIFLUOROMETHANE	ND (1.0)	ug/L
VINYL CHLORIDE	ND (1.0)	ug/L
CHLOROETHANE	ND (1.0)	ug/L
METHYLENE CHLORIDE	ND (20)	ug/L

PAGE 2 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS



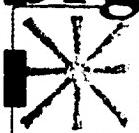
ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

THE PRACTICAL USE OF THE TELESCOPE IN ASTRONOMY.

12-05-53

RECEIVED IN P. O. DEPT.
FEDERAL BUREAU OF INVESTIGATION
U. S. DEPARTMENT OF JUSTICE

erg

ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

FCC REGISTRATION NO. A1355 - JRG ASSOCIATES, INC.

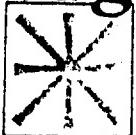
12-05-83

CLIENT ID: 10000000000000000000
 ESR SAMPLE ID: 10000000000000000000
 DATE: 12/05/83
 DATE COLLECTED: 12/05/83

PARAMETER	RESULTS	UNITS
IRON, TOTAL	0.71	mg/L
CHLORIDE	0.67	mg/L
CARBON, TOTAL ORGANIC	0.0	mg/L
CHEMICAL OXYGEN DEMAND	26	mg/L
FUNGEABLES, 601	NO (1.0)	ug/L
CHLOROMETHANE	NO (1.0)	ug/L
BROMOMETHANE	NO (1.0)	ug/L
DICHLORODIFLUOROMETHANE	NO (1.0)	ug/L
VINYL CHLORIDE	NO (1.0)	ug/L
CHLOROETHANE	NO (1.0)	ug/L
METHYLENE CHLORIDE	NO (20)	ug/L
TRICHLOROFLUOROMETHANE	NO (1.0)	ug/L
DICHLOROETHYLENE, 1,1-	NO (1.0)	ug/L
DICHLOROETHANE, 1,1-	NO (1.0)	ug/L
TRANS-1,2-DICHLOROETHYLENE	NO (1.0)	ug/L
CIS-1,2-DICHLOROETHYLENE	NO (1.0)	ug/L
TRICHLOROETHYLENE, 1,1,1-	NO (1.0)	ug/L
1,4-BENZOTETRACHLOROETHANE	NO (1.0)	ug/L
1,2-DICHLOROETHANE	NO (1.0)	ug/L
DICHLOROPROPANE, 1,2-	NO (1.0)	ug/L
TRANS-1,3-DICHLOROPROPENE	NO (1.0)	ug/L
TRICHLOROETHYLENE	NO (1.0)	ug/L
DIBROMOCHLOROMETHANE	NO (1.0)	ug/L
TRICHLOROETHANE, 1,1,2-	NO (1.0)	ug/L
(CIS-1,2-DICHLOROPROPENE)	NO (1.0)	ug/L
1,1-DIACETOXYETHANE, ETHER, 2-	NO (1.0)	ug/L
ERGOCRYPTINE	NO (1.0)	ug/L
TEPHACHLOROETHANE, 1,1,2,2-	NO (1.0)	ug/L
TEPHACHLOROETHYLENE	NO (1.0)	ug/L
CHLOROBENZENE	NO (1.0)	ug/L
DICHLOROBENZENE, 1,2-	NO (1.0)	ug/L
STYRENE	NO (1.0)	ug/L
1,2-DICHLOROBENZENE	NO (1.0)	ug/L
1,3-DICHLOROBENZENE	NO (1.0)	ug/L
1,4-DICHLOROBENZENE	NO (1.0)	ug/L
ETHYLBENZENE	NO (1.0)	ug/L
TOLUENE	NO (1.0)	ug/L
CIS-1,2-DICHLOROETHANE	NO (1.0)	ug/L

PAGE 4 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

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ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

FAX PHENIX AD 41375 - VRS ASSOCIATES, INC

18-05-83

CLIENT I.D.: 100-00000
 ERC SAMPLE NO. 10/096587
 MATRIX NATURAL WATER
 DATE COLLECTED 09-21-83

PARAMETER	RESULTS	UNITS
ALDORIN	ND (0. 10)	ug/L
DIELDRIN	ND (0. 10)	ug/L
ENDRIN	ND (0. 10)	ug/L
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0. 10)	ug/L
METHONYLCHLOR	ND (0. 10)	ug/L
DDD, p,p'-	ND (0. 10)	ug/L
DDE, p,p'-	ND (0. 10)	ug/L
DDT, p,p'-	ND (0. 10)	ug/L
HEPTACHLOR EPOXIDE	ND (0. 10)	ug/L
OIL AND GREASE BY IR	ND (0. 5)	mg/L

CLIENT I.D.: 100-00000
 ERC SAMPLE NO. 10/096588
 MATRIX NATURAL WATER
 DATE COLLECTED 09-21-83

PARAMETER	RESULTS	UNITS
IRON, TOTAL	31	mg/L
CHLORIDE	400	mg/L
CARBON, TOTAL ORGANIC	4	mg/L
CHEMICAL OXYGEN DEMAND	270	mg/L
PURGEABLES, 601		
CHLOROMETHANE	ND (1. 0)	ug/L
BRACHROMETHANE	ND (1. 0)	ug/L
DICHLORODIFLUOROMETHANE	ND (1. 0)	ug/L
1,1-DICHLORO-1,2-DIFLUORETHANE	ND (1. 0)	ug/L
CHLOROETHANE	ND (1. 0)	ug/L
METHYLENE CHLORIDE	ND (20)	ug/L
TRICHLOROFLUOROMETHANE	ND (1. 0)	ug/L
DICHLOROETHYLENE, 1,1-	ND (1. 0)	ug/L
DICHLOROETHANE, 1,1-	ND (1. 0)	ug/L
TRANS-1,2-DICHLOROETHYLENE	ND (1. 0)	ug/L
CHLOROPROP	ND (1. 0)	ug/L
DICHLORETHANE, 1,2-	ND (1. 0)	ug/L
TRICHLOROETHANE, 1,1,1-	ND (1. 0)	ug/L
CARBON TETRACHLORIDE	ND (1. 0)	ug/L
SEMICDICHLOROETHANE	ND (1. 0)	ug/L
DICHLOROPROPANE, 1,2-	ND (1. 0)	ug/L
TRANS-1,3-DICHLOROPROPENE	ND (1. 0)	ug/L
TRICHLOROETHYLENE	ND (1. 0)	ug/L
DIFLUOROCHLOROETHANE	ND (1. 0)	ug/L

ENVIRONMENTAL RESEARCH GROUP, INC.

erg

117 N. First Ann Arbor, Michigan 48104 (313) 662-3104

QUALITY CONTROL SUMMARY

Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number: A1395 Reference: JRB-Kingsley

Date Samples Received: September 30, 1983

Date Samples Extracted: No extraction - all purgeables

Date Samples Analyzed: November 3, 1983

Methodology Employed:
Halocarbon Purgeables EPA Method 601
Aromatic Purgeables EPA Method 602
Halides by Haloscan Interim EPA Method 9022

Sample Quality Control:
ERG's QA/QC requires a duplicate, method spike and blank with each group of samples or with every 10 samples, whichever is larger.

SUMMARY OF QUALITY CONTROL ANALYSIS

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results</u>
09/(096305)	Iron	Duplicate	-----	-----	.49/.49 mg/L
09/(096305)	Iron	Blank	-----	-----	0.012 mg/L
09/(096451)	Chloride	Duplicate	-----	-----	2/1 mg/L
09/(096451)	Chloride	Blank	-----	-----	0.0 mg/L
09/(096451)	Chloride	Method Spike	25	108	28

Sample #'s in () are sample #'s not in project #A1395 but were analyzed along with the project #A1395.

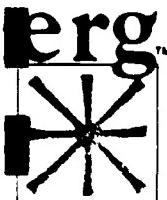
<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results</u>
09/096585	TOC	Duplicate	-----	-----	159.86/150.00 mg/L
09/096585	TOC	Blank	-----	-----	159
09/096585	TOC	Method Spike	10	112	11.6
09/096587	COD	Duplicate	-----	-----	31.4/21.5 mg/L
09/096587	COD	Blank	-----	-----	.007
09/096588	Aldrin	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	Aldrin	Blank	-----	-----	ND(0.10) ug/L
09/096588	Aldrin	Method Spike	.40	63	.25
09/096588	DDT	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	DDT	Blank	-----	-----	ND(0.10) ug/L
09/096588	DDT	Method Spike	.80	94	.75
09/096588	*DDE	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	*DDE	Blank	-----	-----	ND(0.10) ug/L
09/096588	*DDE	Method Spike	.80	150	1.2
09/096588	DDD	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	DDD	Blank	-----	-----	ND(0.10) ug/L
09/096588	DDD	Method Spike	.80	93	.74
09/096588	*Dieldrin	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	*Dieldrin	Blank	-----	-----	ND(0.10) ug/L
09/096588	*Dieldrin	Method Spike	.80	25	.20
09/096588	Endrin	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	Endrin	Blank	-----	-----	ND(0.10) ug/L
09/096588	Endrin	Method Spike	3.2	63	2.0

*DDE - Enhanced recovery because Dieldrin eluting in 6% at same retention time of DDE.

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results</u>
09/096588	Heptachlor Epox.	Duplicate	-----	-----	ND(0.10)/ND(0.10) ug/L
09/096588	Heptachlor Epox.	Blank	-----	-----	ND(0.10) ug/L
09/096588	Heptachlor Epox.	Method Spike	.40	83	.33
09/096585	Chloromethane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Chloromethane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Bromomethane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Bromomethane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichlorodifluoro-methane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichlorodifluoro-methane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Vinyl Chloride	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Vinyl Chloride	Blank	-----	-----	ND(1.0) ug/L
09/096585	Chloroethane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Chloroethane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Methylene Chloride	Duplicate	-----	-----	27 ug/L
09/096585	Methylene Chloride	Blank	-----	-----	11.7 ug/L
09/096585	Trichlorofluoro-methane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Trichlorofluoro-methane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichloroethylene,1,1	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichloroethylene,1,1	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichloroethane,1,1-	Duplicate	-----	-----	ND(1.0) ug/L
09/096586	Dichloroethane,1,1-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Trans-1,2-dichloro-ethylene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Trans-1,2-dichloro-ethylene	Blank	-----	-----	ND(1.0) ug/L

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results</u>
09/096585	Chloroform	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Chloroform	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichloroethane,1,2-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichloroethane,1,2-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Trichloroethane,1,1	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Trichloroethane,1,1	Blank	-----	-----	ND(1.0) ug/L
09/096585	Carbon Tetrachloride	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Carbon Tetrachloride	Blank	-----	-----	ND(1.0) ug/L
09/096585	Bromodichloromethane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Bromodichloromethane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichloropropane,1,2-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichloropropane,1,2-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Trans-1,3-dichloro- propane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Trans-1,3-dichloro- propane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Trichloroethylene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Trichloroethylene	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dibromochloromethane	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dibromochloromethane	Blank	-----	-----	ND(1.0) ug/L
09/096585	Trichloroethane, 1,1,2-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Trichloroethane, 1,1,2-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Cis,1,3-dichloro- propene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Cis,1,3-dichloro- propene	Blank	-----	-----	ND(1.0) ug/L
09/096585	Chloroethylvinyl- ether,2-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Chloroethylvinyl- ether,2-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Bromoform	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Bromoform	Blank	-----	-----	ND(1.0) ug/L

<u>ERG Sample Number</u>	<u>Parameter</u>	<u>Description</u>	<u>Spike Level</u>	<u>Recovery (%)</u>	<u>Analytical Results</u>
09/096585	Tetrachloroethane, 1,1,2,2-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Tetrachloroethane, 1,1,2,2-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Tetrachloroethylene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Tetrachloroethylene	Blank	-----	-----	ND(1.0) ug/L
09/096585	Chlorobenzene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Chlorobenzene	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichlorobenzene,1,3-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichlorobenzene,1,3-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichlorobenzene,1,2-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichlorobenzene,1,2-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Dichlorobenzene,1,4-	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Dichlorobenzene,1,4-	Blank	-----	-----	ND(1.0) ug/L
09/096585	Benzene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Benzene	Blank	-----	-----	ND(1.0) ug/L
09/096585	Toluene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Toluene	Blank	-----	-----	ND(1.0) ug/L
09/096585	Ethylene Benzene	Duplicate	-----	-----	ND(1.0) ug/L
09/096585	Ethylene Benzene	Blank	-----	-----	ND(1.0) ug/L



ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

117 N. FIRST
ANN ARBOR, MICHIGAN 48104 (313) 662-3104

PROJECT
REPORT DATE

A1900
05-25-84

CLIENT P.O.:
REPORT: 7145

SAMPLES RECVD: 04-11-84
REFER TECHNICAL QUESTIONS
TO: SKIP McKEE

CLIENT:
JRB ASSOCIATES, INC
8400 WESTPARK DRIVE
MC LEAN, VA 22102

APPROVED:

ATTENTION: CLAUDIA WIEGAND

RESIDUAL SAMPLES WILL
BE HELD FOR TWO WEEKS

CLIENT I.D.: KZ01
ERG SAMPLE NO: 04/106275
MATRIX: NATURAL WATER
DATE COLLECTED: 04-09-84

PARAMETER	RESULTS	UNITS
IRON, TOTAL	19	mg/L
CHLORIDE	1000	mg/L
CARBON, TOTAL ORGANIC,	28	mg/L
DEMAND, CHEMICAL OXYGEN OIL AND GREASE BY IR	140 ND (1)	mg/L mg/L
PURGEABLES, 601	ND (0.001)	ug/L
CHLOROMETHANE	ND (0.001)	ug/L
BROMOMETHANE	ND (0.001)	ug/L
DICHLORODIFLUOROMETHANE	ND (0.001)	ug/L
VINYL CHLORIDE	ND (0.001)	ug/L
CHLOROETHANE	ND (0.001)	ug/L
METHYLENE CHLORIDE	ND (0.001)	ug/L
TRICHLOROFUOROMETHANE	ND (0.001)	ug/L
DICHLOROETHYLENE, 1,1-	ND (0.001)	ug/L
DICHLOROETHANE, 1,1-	ND (0.001)	ug/L
TRANS-1, 2-DICHLOROETHYLENE	ND (0.001)	ug/L
CHLOROFORM	ND (0.001)	ug/L
DICHLORETHANE, 1,2-	ND (0.001)	ug/L
TRICHLOROETHANE, 1,1,1-	ND (0.001)	ug/L
CARBON TETRACHLORIDE	ND (0.001)	ug/L
BROMODICHLOROMETHANE	ND (0.001)	ug/L
DICHLOROPROPANE, 1,2-	ND (0.001)	ug/L
TRANS-1, 3-DICHLOROPROPENE	ND (0.001)	ug/L
TRICHLOROETHYLENE	ND (0.001)	ug/L
DIBROMOCHLOROMETHANE	ND (0.001)	ug/L
TRICHLOROETHANE, 1,1,2-	ND (0.001)	ug/L
CIS-1, 3-DICHLOROPROPENE	ND (0.001)	ug/L
CHLOROETHYL VINYL ETHER, 2-	ND (0.001)	ug/L

PAGE 1 SEE LAST PAGE FOR EXPLANATION OF SYMBOLS

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ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1900 - JRB ASSOCIATES, INC

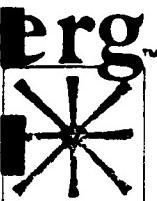
05-25-84

CLIENT I.D.: KZ01
ERG SAMPLE NO: 04/106275
MATRIX: NATURAL WATER
DATE COLLECTED: 04-09-84

PARAMETER	RESULTS	UNITS
BROMOFORM	ND (0. 001)	ug/L
TETRACHLOROETHANE, 1, 1, 2, 2-	ND (0. 001)	ug/L
TETRACHLOROETHYLENE	ND (0. 001)	ug/L
CHLOROBENZENE	ND (0. 001)	ug/L
DICHLOROBENZENE, 1, 3-	ND (0. 001)	ug/L
DICHLOROBENZENE, 1, 2-	ND (0. 001)	ug/L
DICHLOROBENZENE, 1, 4-	ND (0. 001)	ug/L
PURGEABLE AROMATICS		
BENZENE	ND (0. 001)	ug/L
1, 2-DICHLOROBENZENE	ND (0. 001)	ug/L
1, 3-DICHLOROBENZENE	ND (0. 001)	ug/L
1, 4-DICHLOROBENZENE	ND (0. 001)	ug/L
ETHYLBENZENE	ND (0. 001)	ug/L
TOLUENE	ND (0. 001)	ug/L
CHLOROBENZENE	ND (0. 001)	ug/L
ALDRIN	ND (0. 10)	ug/L
DDT, p, p'	ND (0. 10)	ug/L
DDE, p, p'	ND (0. 10)	ug/L
DDD, p, p'	ND (0. 10)	ug/L
DIELDRIN	ND (0. 10)	ug/L
ENDRIN	ND (0. 10)	ug/L
HEPTACHLOR EPOXIDE	ND (0. 10)	ug/L
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0. 10)	ug/L
METHOXYPYRROLE	ND (0. 50)	ug/L

CLIENT I.D.: KZ02
ERG SAMPLE NO: 04/106276
MATRIX: NATURAL WATER
DATE COLLECTED: 04-09-84

PARAMETER	RESULTS	UNITS
IRON, TOTAL	25	mg/L
CHLORIDE	90	mg/L
CARBON, TOTAL ORGANIC,	6	mg/L
DEMAND, CHEMICAL OXYGEN	26	mg/L
OIL AND GREASE BY IR	ND (1)	mg/L
PURGEABLES, 601		
CHLOROMETHANE	ND (0. 001)	ug/L
BROMOMETHANE	ND (0. 001)	ug/L
DICHLORODIFLUOROMETHANE	ND (0. 001)	ug/L
VINYL CHLORIDE	ND (0. 001)	ug/L



ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1900 - JRB ASSOCIATES, INC

05-25-84

CLIENT I.D.: KZ02
ERG SAMPLE NO: 04/106276
MATRIX: NATURAL WATER
DATE COLLECTED: 04-09-84

PARAMETER	RESULTS	UNITS
CHLOROETHANE	ND (0. 001)	ug/L
METHYLENE CHLORIDE	ND (0. 001)	ug/L
TRICHLOROFLUOROMETHANE	ND (0. 001)	ug/L
DICHLOROETHYLENE, 1, 1-	ND (0. 001)	ug/L
DICHLOROETHANE, 1, 1-	ND (0. 001)	ug/L
TRANS-1, 2-DICHLOROETHYLENE	ND (0. 001)	ug/L
CHLOROFORM	ND (0. 001)	ug/L
DICHLORETHANE, 1, 2-	ND (0. 001)	ug/L
TRICHLOROETHANE, 1, 1, 1-	ND (0. 001)	ug/L
CARBON TETRACHLORIDE	ND (0. 001)	ug/L
BROMODICHLOROMETHANE	ND (0. 001)	ug/L
DICHLOROPROPANE, 1, 2-	ND (0. 001)	ug/L
TRANS-1, 3-DICHLOROPROPENE	ND (0. 001)	ug/L
TRICHLOROETHYLENE	ND (0. 001)	ug/L
DIBROMOCHLOROMETHANE	ND (0. 001)	ug/L
TRICHLOROETHANE, 1, 1, 2-	ND (0. 001)	ug/L
CIS-1, 3-DICHLOROPROPENE	ND (0. 001)	ug/L
CHLOROETHYLVINYL ETHER, 2-	ND (0. 001)	ug/L
BROMOFORM	ND (0. 001)	ug/L
TETRACHLOROETHANE, 1, 1, 2, 2-	ND (0. 001)	ug/L
TETRACHLOROETHYLENE	ND (0. 001)	ug/L
CHLOROBENZENE	ND (0. 001)	ug/L
DICHLOROBENZENE, 1, 3-	ND (0. 001)	ug/L
DICHLOROBENZENE, 1, 2-	ND (0. 001)	ug/L
DICHLOROBENZENE, 1, 4-	ND (0. 001)	ug/L
PURGEABLE AROMATICS		
BENZENE	ND (0. 001)	ug/L
1, 2-DICHLOROBENZENE	ND (0. 001)	ug/L
1, 3-DICHLOROBENZENE	ND (0. 001)	ug/L
1, 4-DICHLOROBENZENE	ND (0. 001)	ug/L
ETHYLBENZENE	ND (0. 001)	ug/L
TOLUENE	ND (0. 001)	ug/L
CHLOROBENZENE	ND (0. 001)	ug/L
ALDRIN	ND (0. 10)	ug/L
DDT, p, p'	ND (0. 10)	ug/L
DDE, p, p'	ND (0. 10)	ug/L
DDD, p, p'	ND (0. 10)	ug/L
DIELDRIN	ND (0. 10)	ug/L
ENDRIN	ND (0. 10)	ug/L
HEPTACHLOR EPOXIDE	ND (0. 10)	ug/L
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0. 10)	ug/L
METHOXYCHLOR	ND (0. 50)	ug/L



ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1900 - JRB ASSOCIATES, INC

05-25-84

CLIENT I.D.: 8028-H
ERG SAMPLE NO: 04/106277
MATRIX: NATURAL WATER
DATE COLLECTED: 04-09-84

PARAMETER	RESULTS	UNITS
IRON, TOTAL	0.32	mg/L
CHLORIDE	150	mg/L
CARBON, TOTAL ORGANIC,	6	mg/L
DEMAND, CHEMICAL OXYGEN OIL AND GREASE BY IR	16 ND (1)	mg/L mg/L
PURGEABLES, 601		
CHLOROMETHANE	ND (0.001)	ug/L
BROMOMETHANE	ND (0.001)	ug/L
DICHLORODIFLUOROMETHANE	ND (0.001)	ug/L
VINYL CHLORIDE	ND (0.001)	ug/L
CHLOROETHANE	ND (0.001)	ug/L
METHYLENE CHLORIDE	ND (0.001)	ug/L
TRICHLOROFLUOROMETHANE	ND (0.001)	ug/L
DICHLOROETHYLENE, 1,1-	ND (0.001)	ug/L
DICHLOROETHANE, 1,1-	ND (0.001)	ug/L
TRANS-1, 2-DICHLOROETHYLENE	ND (0.001)	ug/L
CHLOROFORM	ND (0.001)	ug/L
DICHLORETHANE, 1,2-	ND (0.001)	ug/L
TRICHLOROETHANE, 1,1,1-	ND (0.001)	ug/L
CARBON TETRACHLORIDE	ND (0.001)	ug/L
BROMODICHLOROMETHANE	ND (0.001)	ug/L
DICHLOROPROPANE, 1,2-	ND (0.001)	ug/L
TRANS-1, 3-DICHLOROPROPENE	ND (0.001)	ug/L
TRICHLOROETHYLENE	ND (0.001)	ug/L
DIBROMOCHLOROMETHANE	ND (0.001)	ug/L
TRICHLOROETHANE, 1,1,2-	ND (0.001)	ug/L
CIS-1, 3-DICHLOROPROPENE	ND (0.001)	ug/L
CHLOROETHYL VINYL ETHER, 2-	ND (0.001)	ug/L
BROMOFORM	ND (0.001)	ug/L
TETRACHLOROETHANE, 1,1,2,2-	ND (0.001)	ug/L
TETRACHLOROETHYLENE	ND (0.001)	ug/L
CHLOROBENZENE	ND (0.001)	ug/L
DICHLOROBENZENE, 1,3-	ND (0.001)	ug/L
DICHLOROBENZENE, 1,2-	ND (0.001)	ug/L
DICHLOROBENZENE, 1,4-	ND (0.001)	ug/L
PURGEABLE AROMATICS		
BENZENE	ND (0.001)	ug/L
1,2-DICHLOROBENZENE	ND (0.001)	ug/L
1,3-DICHLOROBENZENE	ND (0.001)	ug/L
1,4-DICHLOROBENZENE	ND (0.001)	ug/L
ETHYLBENZENE	ND (0.001)	ug/L
TOLUENE	ND (0.001)	ug/L



ANALYTICAL REPORT

ENVIRONMENTAL RESEARCH GROUP, INC.

ERG PROJECT NO. A1900 - JRB ASSOCIATES, INC

05-25-84

CLIENT I. D. : 8028-H
ERG SAMPLE NO: 04/106277
MATRIX: NATURAL WATER
DATE COLLECTED: 04-09-84

PARAMETER	RESULTS	UNITS
CHLOROBENZENE	ND (0. 001)	ug/L
ALDRIN	ND (0. 10)	ug/L
DDT, p, p'	ND (0. 10)	ug/L
DDE, p, p'	ND (0. 10)	ug/L
DDD, p, p'	ND (0. 10)	ug/L
DIELDRIN	ND (0. 10)	ug/L
ENDRIN	ND (0. 10)	ug/L
HEPTACHLOR EPOXIDE	ND (0. 10)	ug/L
BENZENEHEXACHLORIDE, g (LINDANE)	ND (0. 10)	ug/L
METHOXYCHLOR	ND (0. 50)	ug/L

FR - SEE FIELD REPORT FOR RESULT
NA - NOT APPLICABLE TO TEST REQUESTED
ND - NONDETECTED, DETECTION LIMIT IN ()
SD - SAMPLE DAMAGED
SR - SEE ATTACHED REPORT FOR RESULT
< - POSITIVE RESULT BUT AT UNQUANTIFIABLE CONCENTRATION BELOW INDICATED LEVEL

THANK YOU FOR YOUR BUSINESS !

PAGE 5 LAST PAGE

QUALITY CONTROL SUMMARY

JRB : Kingsley: A1900

SAMPLE NUMBER	PARAMETER	DUPPLICATE VALUE	BLANK VALUE	METHOD SPIKE VALUE	SPIKE LEVEL	% RECOVERY
*106264	Iron	0.416/0.428	0.015	0.534		90
*106130	Chloride	4.0/4.0	0	29	25	100
*106263	TOC	ND(2)/ND(2)	ND(2)	20	19	91
106276	COD	27.0/24.8	24.5	-----	-----	-----
*****	011 & Grease	-----	ND(1)	-----	-----	-----
106275	Aldrin	ND(0.10)/ND(0.10)	ND(0.10)	0.23	0.40	59
106275	Heptachlor Epox.	ND(0.10)/ND(0.10)	ND(0.10)	0.26	0.40	66
106275	DDE	ND(0.10)/ND(0.10)	ND(0.10)	0.50	0.80	63
106275	DDD	ND(0.10)/ND(0.10)	ND(0.10)	0.51	0.80	64
106275	DDT	ND(0.10)/ND(0.10)	ND(0.10)	0.45	0.80	56
106275	Dieldrin	ND(0.10)/ND(0.10)	ND(0.10)	0.33	0.40	84
106275	Endrin	ND(0.10)/ND(0.10)	ND(0.10)	1.95	1.6	12?
106275	Lindane	ND(0.10)/ND(0.10)	ND(0.10)	0.27	0.40	68
106275	Methoxychlor	ND(0.50)/ND(0.50)	ND(0.50)	-----	-----	-----
106277	Purgeable Halocarbons & Aromatics	ND(0.001)	ND(0.001)	0.01/0.022 0.025	0.020/0.021 0.020	91/105/ 125

*This is a sample number that is not part of project #A 1900 but was analyzed with the project #A 1900.

**Cannot run duplicates, have to analyze the complete sample.

***All analytical results are blank subtracted.

QUALITY CONTROL SUMMARY

Submitted To:

JRB Associates, Inc.
8400 Westpark Drive
McLean, VA 22102

Attn: Claudia Wiegand

Project Number:

A 1900 Reference: JRB-Kingsley

Date Samples Received:

April 11, 1984

Date Samples Extracted:

April 12, 1984

Date Samples Analyzed:

April 18, 19, 27, 1984
May 3, 1984

Methodology Employed:

Halocarbon Purgeables EPA Method 601
Aromatic Purgeables EPA Method 602
EPA 600 Method for chemical analysis
of water and wastes. Method 413.2
416.1

Pesticides EPA Method 608

Sample Quality Control:

ERG's QA/QC requires a duplicate method
spike and blank with each group of samples
or with every 10 samples, whichever is
larger.

APPENDIX H
HEALTH AND SAFETY PLAN

1.0 SAFETY PLAN

1.1 PURPOSE

The purpose of this safety plan is to summarize the procedures used by JRB Associates to accomplish the USAF Installation Restoration Program Phase II field survey at Kingsley Field, Oregon. This plan is intended to apply to JRB Associates (hereafter "JRB"), subcontractors to JRB, and employees of other firms working under the technical direction of JRB at the site of the investigation.

1.2 WORK DESCRIPTION

The work to be performed will determine whether or not environmental contamination has resulted from waste disposal practices at Kingsley Field, Oregon; and should contamination be found estimates of the magnitude and extent of the contamination will be provided.

1.3 TECHNICAL EFFORT

An electrical resistivity survey will be performed around Landfill No. 3. The results of this investigation will be used to position two downgradient monitoring wells and to provide a basis for selection of two off-base domestic wells for sample collection and analysis. Standard penetration tests and split spoon sampling shall be done as borings are made. Monitoring wells will be installed in the borings. Wells will be developed, water levels measured and water samples shall be taken in sets of two from each well; one complete set when the seasonal water table is high, and one set when the seasonal water table is low. The domestic wells to be sampled will also be sampled at seasonal high and low water tables.

Groundwater samples shall be analyzed for purgeable halocarbons and aromatics, total iron, chloride, total organic carbon (TOC), chemical oxygen demand (COD), oils and greases and chlorinated hydrocarbon pesticides.

1.4 ACCIDENT PREVENTION

All on-site project personnel will read and maintain a copy of this safety plan and safety precautions. All on-site personnel will be instructed as to avoidance of recognized hazards prior to beginning work on the job site. Safety meetings will be held to identify and evaluate possible hazards and problems before the start of work.

JRB Corporate Policy B-19-1 states:

"The personal and collective safety and health of all employees of this company is of primary importance. The prevention of occupationally (work related) caused injuries and illnesses is of such consequence that it shall be given precedence over operating productivity.

Safety shall be practiced by all personnel at all times. Only safe methods and equipment shall be used.

It is the company's intent to always maintain effective standards for guarding against injuries and illnesses while on the job. To be successful, proper attitudes toward the prevention of injuries and illnesses on the part of all employees is required. Success in all safety and health matters also depends upon cooperation among the company, its supervisors, and all employees, and also between each employee and fellow workers. Only through such cooperative attitudes and efforts can a safety record in the best interest of all be established and preserved.

Our safety and health program is designed to reduce the number of injuries and illnesses to a minimum. Our goal is zero accidents, injuries and illnesses."

In an effort to protect our employees the following standards will be met:

- All employees shall follow safe practices, use personal protective equipment as required, render every possible aid to safety operations, and report all unsafe conditions or practices.
- Work shall be well planned and supervised to prevent injuries.
- All employees shall be given frequent accident prevention instructions.
- Supervisors shall insist on employees observing and obeying every rule, regulation and order as is necessary for the safe conduct of the work.
- All unsafe, unhealthy or hazardous conditions or places shall be immediately placed off limits, out of order, etc., and then promptly removed or corrected.
- No one shall knowingly be permitted or required to work with impaired ability or alertness caused by fatigue, illness or other factors such that the employee or others may be exposed to accidents or injury.
- No one will be allowed on the job while under the influence of intoxicating liquor or drugs.
- Horseplay, scuffling and other acts which have or tend to have an adverse influence on the safety or well-being of employees are prohibited.
- Crowding or pushing when boarding or leaving any vehicle or other conveyance is prohibited.
- Employees shall be alert to see that all guards and other protective devices are in their proper places and adjusted to operation equipment and shall report deficiencies promptly.
- Workers shall not handle or tamper with any tools, equipment, machinery, or facilities not within the scope of their duties, unless they are thoroughly qualified and have received instructions from their supervisor.

- All injuries shall be reported promptly, so that arrangements can be made for medical or first-aid treatment.
- When lifting heavy objects, use the large muscles of the leg instead of the smaller muscles of the back.
- When involved in activities such as welding, carpentry, etc., protect the eyes at all times through the proper use of goggles, hoods, etc.
- Know where you are going and how you are going to get there. Look before you move.
- Watch out for others; they may not be aware of what you are doing or where you are going.
- Wash thoroughly after handling injurious or poisonous substances, and follow all special instructions from authorized sources. Hands should be thoroughly cleaned just prior to eating.
- Loose or frayed clothing, dangling ties, finger rings, etc., shall not be worn near moving machinery or other sources of entanglement.
- Apparatus, tools, equipment and machinery shall not be repaired or adjusted while in operation, nor shall oiling of moving parts be attempted, except on equipment that is designed or fitted with safeguards to protect the person performing the work.
- Use common sense. If you do not know, don't do it.

1.5 OBSERVANCE OF USAF REGULATIONS

JRB and its subcontractors will observe and cooperate with all base regulations regarding access, vehicle operation, personal conduct, etc. while on base. Specifically: 1) all personnel will obtain passes to enter base property and will check in and out through base guard stations, 2) all vehicles used on site will carry current registration and inspection information, and 3) all vehicle/equipment operators will carry valid driver/operator licenses.

1.6 SANITATION

Drinking water will be obtained from local culinary sources and dispensed from cooler cans and disposable paper cups. Every effort will be made to establish and maintain sanitary job conditions.

1.7 FIRST AID AND MEDICAL FACILITIES

JRB and its subcontractors will have available first aid kits for treatment of minor injuries. All on site project personnel will be made familiar with the location and instructions to the nearest emergency medical care facility should emergency treatment be required.

1.8 ACCIDENT REPORTING

Accidents will be reported within one hour. All required accident report forms will be promptly completed. Any accident shall be reported to and aid assistance secured through the Ms. Lois Seibt, the Kingsley Field Environmental Coordinator. Base telephone number is 882-4411, Extension 323.

2.0 SAFETY PRECAUTIONS

2.1 ELECTRICAL RESISTIVITY SURVEY

2.1.1 Personnel

- A. Only qualified personnel with related field experience will be used for this work.
- B. All drivers will have a valid driver's license.
- C. Personal clothing standards will be enforced. Minimum requirements are listed below:
 - 1. Short sleeve shirt
 - 2. Long trousers
 - 3. Leather boots or work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
 - 4. Hard hats are optional since this is not a construction activity and will not take place in construction areas.
- D. The field crew chief or geophysicist in charge on the site will be the job site safety officer and will be responsible for crew safety.
- E. All personnel will be familiar with the location of the nearest emergency medical facility as well as direct routes to that facility.

2.2 DRILLING ACTIVITIES

2.2.1 Personnel

- A. Only qualified personnel with related field experience will be used for this work.
- B. All drivers will have a valid driver's license.
- C. Personal clothing standards will be enforced. Minimum requirements are listed below:

1. Short sleeve shirt
 2. Long trousers
 3. Safety toe leather boots or work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
 4. Hard hats will be required since this is a construction activity and will take place on and around overhead heavy equipment.
 5. Hearing protection in the form of either disposable foam ear plugs, reusable rubber ear plugs or ear muff type noise attenuators.
- D. JRB's field geologist or project manager will be on site and will be the job site safety officer responsible for crew safety.
- E. All personnel will be familiar with the location of the nearest emergency medical facility as well as direct routes to that facility.

2.3 WELL DEVELOPMENT AND FLUSHING ACTIVITIES

2.3.1 Safety Training

Persons designated to develop and flush monitoring wells will be instructed regarding the potential health and safety hazards associated with the work prior to commencing field activities. Specifically, the following topics will be covered in the training session:

- A. Potential routes of contact with toxic and/or corrosive substances
 1. Skin contact/adsorption
 2. Eye contact
 3. Inhalation
 4. Ingestion
- B. Types, proper use, limitations and maintenance of applicable protective clothing and equipment
 1. Safety helmet
 2. Hearing protection
 3. Chemical goggles
 4. Impervious/chemical resistant gloves
 5. Impervious/chemical resistant safety-toe boots
 6. Impervious body coverings (aprons, blouse, trousers)
- C. Respiratory protection using half-facepiece air purifying respirator with replaceable filter cartridges
 1. Hierarchy of protective controls: engineered, administrative, work practice, personal protective clothing and equipment.

2. Forms of respiratory protection: air purifying (disposal/reusable), air supplied, self contained.
3. Selection of respiratory protection based on hazard: dust, fume, mist, gas, irritant, poor warning properties.
4. NIOSH certification/approval of respiratory protection equipment.
5. Medical/physical fitness to wear respiratory protection.
6. Reporting of accidents and availability of medical assistance.

2.3.2 Protective Clothing and Equipment

All development and/or flushing of monitoring wells will be performed by persons garbed in the following minimum protective items:

1. Long sleeve shirt
2. Long trousers
3. Leather boots, work shoes or other appropriate protective shoes or boots. Canvas shoes, tennis or deck shoes are not acceptable.
4. Hearing protection in the form of either disposable foam ear plugs, reusable rubber ear plugs or ear muff type noise attenuators when using generators or compressors.
5. Impervious/chemical resistant gloves shall be worn when hand-bailing monitoring wells.
6. Hard hats are optional since this is not a construction activity and will not take place in construction areas.

2.3.3 Work Practices

All development and/or flushing activities will be conducted by persons wearing at least the minimum protective items listed above.

Field personnel will stand upwind from discharge ports or hoses when using mechanical methods of development and/or flushing.

Odorous water conditions will result in donning of organic vapor/acid gas respiratory protection.

All equipment used in well development and/or flushing will be cleaned and rinsed with fresh water before being used in another well.

No food will be consumed at the well site. Field personnel must wash thoroughly after participating in well development and/or flushing activities. Hands and face should be thoroughly cleaned just prior to eating.

2.4 COLLECTION AND HANDLING OF SPLIT SPOON SAMPLES AND/OR DRILLING SAMPLES

2.4.1 Safety Training

Persons designated to collect or handle split spoon soil samples will be instructed regarding the potential health and safety hazards associated with the work prior to commencing field activities. Specifically, the following topics will be covered in the training session:

- A. Potential routes of contact with toxic and/or corrosive substances
 - 1. Skin contact/adsorption
 - 2. Eye contact
 - 3. Inhalation
 - 4. Ingestion
- B. Types, proper use, limitations and maintenance of applicable protective clothing and equipment
 - 1. Safety helmet
 - 2. Chemical goggles
 - 3. Impervious/chemical resistant gloves
 - 4. Impervious/chemical resistant safety-toe boots
 - 5. Impervious body coverings (aprons, blouse, trousers)
- C. Respiratory protection using half-facepiece air purifying respirator with replaceable filter cartridges
 - 1. Hierarchy of protective controls: engineered, administrative, work practice, personal protective clothing and equipment.
 - 2. Forms of respiratory protection: air purifying (disposal/reusable), air supplied, self contained.
 - 3. Selection of respiratory protection based on hazard: dust, fume, mist, gas, irritant, poor warning properties.
 - 4. NIOSH certification/approval of respiratory protection equipment.
 - 5. Medical/physical fitness to wear respiratory protection.
- D. Reporting of accidents and availability of medical assistance.

2.4.2 Protective Clothing and Equipment

All sample collection work will be performed by persons garbed in the following minimum protective items:

- 1. Long sleeve shirt
- 2. Long trousers
- 3. Chemical resistant/impervious boots
- 4. Gauntlet style, chemical resistant/impervious gloves
- 5. Chemical eye goggles or face shield

Depending on soil or groundwater properties, site conditions and weather, other items may be used for supplemental protection. Such items may include:

1. Respiratory (half-facepiece, air purifying)
2. Impervious apron
3. Impervious work blouse and/or trousers

2.4.3 Work Practices During Sampling

All sampling activities will be conducted by persons wearing at least the minimum protective items listed above.

Field personnel will stand upwind from the sampling location and upwind from extracted samples during their handling.

Odorous soil, water or site conditions will result in donning of organic vapor/acid gas respiratory protection. Similarly, dusty site or soil sample conditions will result in donning particulate filter type respirators.

Soil or water samples which display contamination will be removed from the site in suitable sealed sample containers for analysis and eventual disposal.

Sample containers will be resistant to solution and breakage, and they must have a leakproof seal. If any of these conditions are not satisfied, the container should not be used.

Reagents used for sample preservation and solvents used for cleaning bailers, etc. shall be stored in approved clearly labelled containers with appropriate warning labels.

Pipettes used for delivery of reagents for sample preservation shall be dedicated to specific reagents and must be cleaned and rinsed before storage after sampling.

No food will be consumed at the well site. Field personnel must wash thoroughly after handling caustic, acidic, corrosive or hazardous substances. Personnel shall follow all special instructions on decontamination from authorized sources. Hands and face should be thoroughly cleaned just prior to eating.

2.4.4 Equipment, Personal and Site Hygiene

Punctured, internally contaminated, cracked, stubbornly soiled, protective items will be disposed of in sealed plastic bags.

Paper, rags, and other disposables used on site or in equipment/sample container clean up will be disposed of in sealed plastic bags.

Gloves, boots, other protective coverings and sampling equipment will be rinsed with clean water at the site before eating, drinking and at the conclusion of each day's activities. Respirators, if worn, will be used during the rinse down activity.

Where visual observation of cuttings or detected odors show contamination, personal protective items will be placed in clean bags after rinsing for transportation to an area where they can be thoroughly cleaned with detergent and water and inspected for leaks, cracks or other damage. Where only clean cuttings are present, protective items will be rinsed, inspected, dried and otherwise made ready for reuse. Respirators will be thoroughly cleaned, disinfected and repaired after each use.

Drill cuttings which display odor or visual contamination will be sampled for laboratory chemical analysis. Ultimate disposal of the cuttings will be based on chemical analyses.

Odorous soil cores or site conditions will result in donning of organic vapor/acid gas respiratory protection. Similarly, dusty site or drill cuttings will result in donning particulate filter type respirators.

Soil cuttings from well drilling which display contamination will be removed from the site in suitable sealed containers or drums for eventual disposal, or placed back into the borehole.

No food will be consumed on the drilling site. Employees will thoroughly wash their hands, forearms and face before consuming food or beverages other than water held in disposable cups. Drinking water will be available at the perimeter of the site being investigated. Disposable cups will be used to consume water after protective gloves are removed.

APPENDIX I

**RERANKING OF LANDFILL NO. 3 USING THE
USAF HAZARD ASSESSMENT RATING METHODOLOGY (HARM)**

WASTE DISPOSAL SITE AND SPILL AREA ASSESSMENT AND RATING FORM
 (Rerated June 1983 following Phase II investigations)

Name of Site Landfill No. 3 Page 1 of 2
 Location SE corner, S of Runway 25, W of Homedale Road
 Owner/Operator USAF-Kingsley Field, Oregon
 Comments Landfill operated 1961-1979. Contained construction debris; coal flyash; small quantities pesticide wastes and medical wastes; and waste paint, thinners, and solvents.

RATING FACTOR	FACTOR RATING (0-3)	MULTIPLIER	FACTOR SCORE	MAXIMUM POSSIBLE SCORE
RECEPTORS				
Population Within 1,000 Feet	1	4	4	12
Distance to Nearest Drinking Water Well	3	15	45	45
Distance to Reservation Boundary	3	6	18	18
Land Use/Zoning	2	3	6	.9
Critical Environments	0	12	0	36
Water Quality of Nearby Surface Water Body	0	6	0	18
Number of Assumed Values = <u>0</u> Out of 6		SUBTOTALS	<u>73</u>	<u>138</u>
Percentage of Assumed Values = <u>0</u> %		SUBSCORE		<u>53</u>
Number of Missing Values = <u>0</u> Out of 6		(Factor Score Divided by Maximum Score and Multiplied by 100)		
Percentage of Missing Values = <u>0</u> %				

PATHWAYS				
Evidence of Water Contamination	2	10	20	30
Level of Water Contamination	1	15	15	45
Type of Contamination. Soil/Biota	0	5	0	15
Distance to Nearest Surface Water	3	4	12	12
Depth to Groundwater	3	7	21	21
Net Precipitation	2	6	6	18
Soil Permeability	2	6	12	18
Bedrock Permeability	0	4	0	12
Depth to Bedrock	0	4	0	12
Surface Erosion	0	4	0	12
Number of Assumed Values = <u>0</u> Out of 10		SUBTOTALS	<u>86</u>	<u>195</u>
Percentage of Assumed Values = <u>0</u> %		SUBSCORE		<u>44</u>
Number of Missing Values = <u>0</u> Out of 10		(Factor Score Divided by Maximum Score and Multiplied by 100)		
Percentage of Missing Values = <u>0</u> %				

Note: This HARM Rating Form is no longer used by the USAF (see Figure I-2) but is used here solely for comparison against the February 1982 rating.

WASTE CHARACTERISTICS

Page 2 of 2

Hazardous Rating: Judgemental rating from 30 to 100 points based on the following guidelines:

Points

30	Closed domestic-type landfill, old site, no known hazardous wastes
40	Closed domestic-type landfill, recent site, no known hazardous wastes
50	Suspected small quantities of hazardous wastes
60	Known small quantities of hazardous wastes
70	Suspected moderate quantities of hazardous wastes
80	Known moderate quantities of hazardous wastes
90	Suspected large quantities of hazardous wastes
100	Known large quantities of hazardous wastes

SUBSCORE

50Reason for Assigned Hazardous Rating:

Short-term landfill with only small quantities of hazardous wastes known to be disposed of in landfill. One cubic yard of DDT pesticide wastes and/or containers suspected.

WASTE MANAGEMENT PRACTICES

RATING FACTOR	FACTOR RATING (0-3)	MULTIPLIER	FACTOR SCORE	MAXIMUM POSSIBLE SCORE
Record Accuracy and Ease of Access to Site	1	7	7	21
Hazardous Waste Quantity (assumed)	1	7	7	21
Total Waste Quantity	1	4	4	12
Waste Incompatibility (assumed)	0	3	0	9
Absence of Liners or Confining Beds	3	6	18	18
Use of Leachate Collection System	3	6	18	18
Use of Gas Collection Systems (not applicable)	0	2	0	6
Site Closure	2	8	16	24
Subsurface Flows	3	7	21	21
Number of Assumed Values = <u>2</u> Out of 9			SUBTOTALS	<u>91</u> / <u>150</u>
Percentage of Assumed Values = <u>22%</u>			SUBSCORE	<u>61</u>
Number of Missing and Non-Applicable Values = <u>1</u> Out of 9			(Factor Score Divided by Maximum Score and Multiplied by 100)	
Percentage of Missing and Non-Applicable Values = <u>11%</u>				
Overall Number of Assumed Values = <u>2</u> Out of 25			OVERALL SCORE	<u>51.5</u>
Overall Percentage of Assumed Values = <u>8%</u>				

(Receptors Subscore X 0.22 plus Pathways Subscore X 0.30 plus Waste Characteristics Subscore X 0.24 plus Waste Management Subscore X 0.24)

WASTE DISPOSAL SITE AND SPILL AREA ASSESSMENT AND RATING FORM*

*Original rating: February 1982 before Phase II investigation.

(source: IRP Phase I Records Search, Kingsley Field, Oregon, by CH2M-Hill, Feb. 1982)

Name of Site No. 3 - Base Landfill
 Location Kingsley Field
 Owner/Operator Kingsley Field
 Comments 17c unutilized domestic fill

RATING FACTOR	FACTOR RATING (0-3)	MULTIPLIER	FACTOR SCORE	MAXIMUM POSSIBLE SCORE
RECEPTORS				
Population Within 1,000 Feet	1	4	4	12
Distance to Nearest Drinking Water Well	3	15	45	45
Distance to Reservation Boundary	3	6	18	18
Land Use/Zoning	2	3	6	9
Critical Environments	0	12	0	36
Water Quality of Nearby Surface Water Body	0	6	0	18
Number of Assumed Values = _____ Out of 6			SUBTOTALS	<u>73</u> <u>138</u>
Percentage of Assumed Values = _____ %			SUBSCORE	<u>53</u>
Number of Missing Values = _____ Out of 6			(Factor Score Divided by Maximum Score and Multiplied by 100)	
Percentage of Missing Values = _____ %				

PATHWAYS				
Evidence of Water Contamination	1	10	10	30
Level of Water Contamination	1	15	15	45
Type of Contamination, Soil/Biota	3	5	15	15
Distance to Nearest Surface Water	3	4	12	12
Depth to Groundwater	3	7	21	21
Net Precipitation	1	6	6	18
Soil Permeability	2	6	12	18
Bedrock Permeability	0	4	0	12
Depth to Bedrock	0	4	0	12
Surface Erosion	2	4	8	12
Number of Assumed Values = _____ Out of 10			SUBTOTALS	<u>99</u> <u>195</u>
Percentage of Assumed Values = _____ %			SUBSCORE	<u>51</u>
Number of Missing Values = _____ Out of 10			(Factor Score Divided by Maximum Score and Multiplied by 100)	
Percentage of Missing Values = _____ %				

WASTE CHARACTERISTICS

Hazardous Rating: Judgemental rating from 30 to 100 points based on the following guidelines:

Points

- | | |
|-----|-----------------------------------------------------------------------|
| 30 | Closed domestic-type landfill, old site, no known hazardous wastes |
| 40 | Closed domestic-type landfill, recent site, no known hazardous wastes |
| 50 | Suspected small quantities of hazardous wastes |
| 60 | Known small quantities of hazardous wastes |
| 70 | Suspected moderate quantities of hazardous wastes |
| 80 | Known moderate quantities of hazardous wastes |
| 90 | Suspected large quantities of hazardous wastes |
| 100 | Known large quantities of hazardous wastes |

SUBSCORE

90

Reason for Assigned Hazardous Rating:

long term base landfill
1 cubic yard DDT reported

WASTE MANAGEMENT PRACTICES

RATING FACTOR	FACTOR RATING (0-3)	MULTIPLIER	FACTOR SCORE	MAXIMUM POSSIBLE SCORE
Record Accuracy and Ease of Access to Site	1	7	7	21
Hazardous Waste Quantity	2	7	14	21
Total Waste Quantity	2	4	8	12
Waste Incompatibility <u>Assume</u>	1	3	3	9
Absence of Liners or Confining Beds	3	6	18	18
Use of Leachate Collection System	3	6	18	18
Use of Gas Collection Systems	3	2	6	6
Site Closure	2	8	16	24
Subsurface Flows	3	7	21	21
Number of Assumed Values = <u>1</u> Out of 9		SUBTOTALS	<u>111</u>	<u>150</u>
Percentage of Assumed Values = <u>11%</u>		SUBSCORE		<u>74</u>
Number of Missing and Non-Applicable Values = <u> </u> Out of 9		(Factor Score Divided by Maximum Score and Multiplied by 100)		
Percentage of Missing and Non-Applicable Values = <u> </u> %				
Overall Number of Assumed Values = <u>1</u> Out of 25		OVERTOTAL SCORE		<u>66</u>
Overall Percentage of Assumed Values = <u>4%</u>		(Receptors Subscore x 0.22 plus Pathways Subscore x 0.30 plus Waste Characteristics Subscore x 0.24 plus Waste Management Subscore x 0.24)		

HAZARD ASSESSMENT RATING METHODOLOGY (HARM)

BACKGROUND

The Department of Defense (DOD) has established a comprehensive program to identify, evaluate, and control problems associated with past disposal practices at DOD facilities. One of the actions required under this program is to:

"develop and maintain a priority listing of contaminated installations and facilities for remedial action based on potential hazard to public health, welfare, and environmental impacts." (Reference: DEQPPM 81-5, 11 December 1981).

Accordingly, the United States Air Force (USAF) has sought to establish a system to set priorities for taking further actions at sites based upon information gathered during the records search phase of its Installation Restoration Program (IRP).

The first site rating model was developed in June 1981 at a meeting with representatives from the USAF Occupational Environmental Health Laboratory (OEHL), Air Force Engineering Services Center (AFESC), Engineering-Science (ES) and CH2M Hill. The basis for this model was a system developed for EPA by JRB Associates of McLean, Virginia. The JRB model was modified to meet Air Force needs.

After using this model for six months at over 20 Air Force installations, certain inadequacies became apparent. Therefore, on January 26 and 27, 1982, representatives of USAF/OEHL, AFESC, various major commands, Engineering Science, and CH2M Hill met to address the inadequacies. The result of the meeting was a new site rating model designed to present a better picture of the hazards posed by sites at Air Force installations. The new rating model described in this presentation is referred to as the Hazard Assessment Rating Methodology.

PURPOSE

The purpose of the site rating model is to provide a relative ranking of sites of suspected contamination from hazardous substances. This model will assist

the Air Force in setting priorities for follow-on site investigations and confirmation work under Phase II of IRP.

This rating approach (see Figure I.1) is used only after it has been determined that (1) potential for contamination exists (hazardous wastes present in sufficient quantity), and (2) potential for migration exists. A site can be deleted from consideration for rating on either basis.

DESCRIPTION OF MODEL

Like the other hazardous waste site ranking models, the U.S. Air Force's site rating model uses a scoring form to rank sites for priority attention (see Figure I.2). However, in developing this model, the designers incorporated some special features to meet specific DOD program needs.

The model uses data obtained during the record search portion (Phase I) of the IRP. Scoring judgments and computations are easily made. In assessing the hazards at a given site, the model develops a score based on the most likely routes of contamination and the worst hazards at the site. Sites are given low scores only if there are clearly no hazards at the site. This approach meshes well with the policy for evaluating and setting restrictions on excess DOD properties.

As with the previous model, this model considers four aspects of the hazard posed by a specific site: (1) the possible receptors of the contamination; (2) the waste and its characteristics; (3) potential pathways for waste contaminant migration; and, (4) any efforts to contain the contaminants. Each of these categories contains a number of rating factors that are used in the overall hazard rating (see Table I.1).

The receptors category rating is calculated by scoring each factor, multiplying by a factor weighting constant and adding the weighted scores to obtain a total category score.

The pathways category rating is based on evidence of contaminant migration or an evaluation of the highest potential (worst case) for contaminant migration along one of three pathways. If evidence of contaminant migration exists, the category is given a subscore of 80 to 100 points. For indirect evidence 80

points are assigned and for direct evidence 100 points are assigned. If no evidence is found, the highest score among three possible routes is used. These routes are surface water migration, flooding, and groundwater migration. Evaluation of each route involves factors associated with the particular migration route. The three pathways are evaluated and the highest score among all four of the potential scores is used.

The waste characteristics category is scored in three steps. First, a point rating is assigned based on an assessment of the waste quantity and the hazard (worst case) associated with the site. The level of confidence in the information is also factored into the assessment. Next, the score is multiplied by a waste persistence factor which acts to reduce the score if the waste is not very persistent. Finally, the score is further modified by the physical state of the waste. Liquid wastes receive the maximum score, while scores for sludges and solids are reduced.

The scores for each of the three categories are then added together and normalized to a maximum possible score of 100. At this point the waste management practice category is scored. Sites at which there is no containment are not reduced in score. Scores for sites with limited containment can be reduced by five percent. If a site is contained and well managed, its score can be reduced by 90 percent. The final site score is calculated by applying the waste management practices category factor to the sum of the scores for the other three categories.

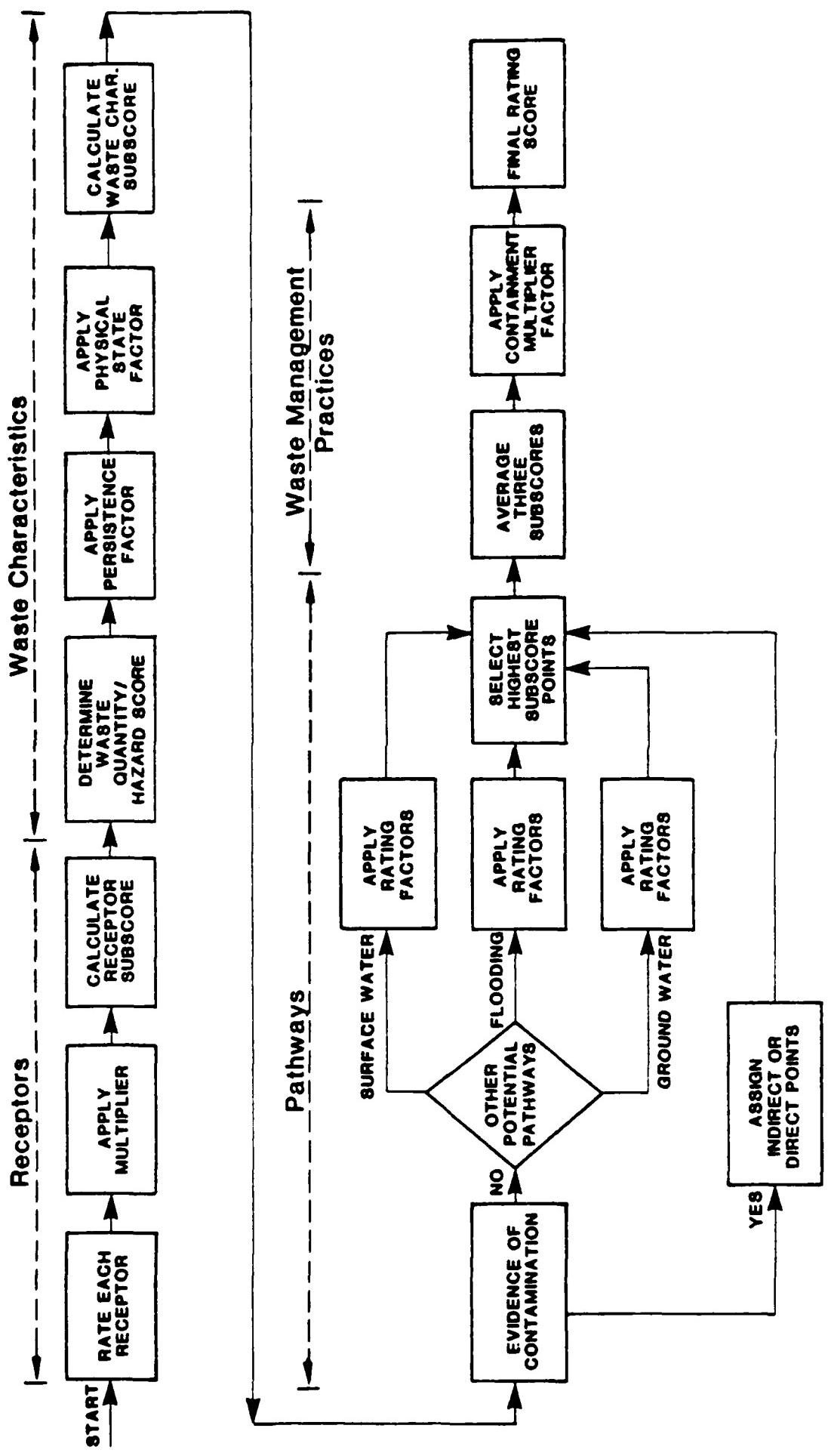


Figure I-1
HAZARD ASSESSMENT RATING METHODOLOGY FLOW CHART
(from USAF)

Figure I-2
HAZARD ASSESSMENT RATING METHODOLOGY FORM

Page 1 of 2

Name of Site: _____

Location: _____

Date of Operation or Occurrence: _____

Owner/Operator: _____

Comments/Description: _____

Site Rated By: _____

I. RECEPTORS

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
A. Population within 1,000 feet of site		4		12
B. Distance to nearest well		10		30
C. Land use/zoning within 1 mile radius		3		9
D. Distance to reservation boundary		6		18
E. Critical environments within 1 mile radius of site		10		30
F. Water quality of nearest surface water body		6		18
G. Groundwater use of uppermost aquifer		9		27
H. Population served by surface water supply within 3 miles downstream of site		6		18
I. Population served by groundwater supply within 3 miles of site		6		18
SUBTOTAL				180
Receptors subscore (100 x factor score subtotal/maximum score subtotal)				

II. WASTE CHARACTERISTICS

A. Select the factor score based on the estimated quantity, the degree of hazard, and the confidence level of the information.

1. Waste quantity (S = small, M = medium, L = large) _____

2. Confidence level (C = confirmed, S = suspected) _____

3. Hazard Rating (H = high, M = medium, L = low) _____

Factor Subscore A (from 20 to 100 based on factor score matrix) _____

B. Apply persistence factor

Factor Subscore A x Persistence Factor = Subscore B

_____ x _____ = _____

C. Apply physical state multiplier

Subscore B x Physical State Multiplier = Waste Characteristics Subscore

_____ x _____ = _____

Figure I-2 (cont'd)

III. PATHWAYS

- A. If there is evidence of migration of hazardous contaminants, assign maximum factor subscore of 100 points for direct evidence or 80 points for indirect evidence. If direct evidence exists then proceed to C. If no evidence or indirect evidence exists, proceed to B.

Subscore = _____

- B. Rate the migration potential for 3 potential pathways: surface water migration, flooding, and groundwater migration. Select the highest rating, and proceed to C.

Rating Factor	Factor Rating (0-3)	Multiplier	Factor Score	Maximum Possible Score
1. SURFACE WATER MIGRATION				
Distance to nearest surface water		8		24
Net precipitation		6		18
Surface erosion		8		24
Surface permeability		6		18
Rainfall intensity		8		24
SUBTOTAL				108
Subscore (100 x factor score subtotal / maximum score subtotal)				
2. FLOODING				
Subscore (100 x factor score / 3)				
3. GROUNDWATER MIGRATION				
Depth to groundwater		8		24
Net precipitation		6		18
Soil permeability		8		24
Subsurface flows		8		24
Direct access to groundwater		8		24
SUBTOTAL				114
Subscore (100 x factor score subtotal / maximum score subtotal)				

C. Highest pathway subscore

Enter the highest subscore value from A, B-1, B-2, or B-3, above.

Pathway Subscore = _____

IV. WASTE MANAGEMENT PRACTICES

- A. Average the three subscores for receptors, waste characteristics, and pathways.

Receptors _____

Waste Characteristics _____

Pathways _____

TOTAL _____

Divided by 3 = Gross Total Score: _____

- B. Apply factor for waste containment from waste management practices.

Gross Total Score x Waste Management Practices Factor = Final Score

_____ x _____ = _____

HAZARD ASSESSMENT RATING METHODOLOGY GUIDELINES

<u>I. REGULATORY CATEGORIES</u>		<u>Rating Scale Levels</u>			<u>Multiplier</u>
<u>Rating Factors</u>	<u>0</u>	<u>1</u>	<u>2</u>	<u>3</u>	
A. Population within 1,000 feet (includes on-base facilities)	0	1 - 25	26 - 100	Greater than 100	4
B. Distance to nearest water well	Greater than 3 miles	1 to 3 miles	3,001 feet to 1 mile	0 to 3,000 feet	10
C. Land Use/zoning (within 1 mile radius)	Completely remote (zoning not applicable)	Agricultural	Commercial or Industrial	Residential	3
D. Distance to installation boundary	Greater than 2 miles	1 to 2 miles	1,001 feet to 1 mile	0 to 1,000 feet	6
E. Critical environments (within 1 mile radius)	Not a critical environment	Natural areas	Pristine natural areas; minor wetlands; preserved areas; presence of recharge areas; major wetlands.	Major habitat of an endangered or threatened species; presence of areas; presence of economically important natural certain natural sources susceptible to contamination.	10
F. Water Quality/use designation of nearest surface water body	Agricultural or industrial use.	Recreation, propagation and management of fish and wildlife.	Shellfish propagation and harvesting.	Potable water supplies	6
G. Ground-Water use of uppermost aquifer	Not used, other sources readily available.	Commercial, industrial, or irrigation, very limited other water sources.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	Drinking water, no municipal water available; commercial, industrial, or irrigation, no other water source available.	9
H. Population served by surface water supplies within 3 miles downstream of site	0	1 - 50	51 - 1,000	Greater than 1,000	6
I. Population served by aquifer supplies within 3 miles of site	0	1 - 50	51 - 1,000	Greater than 1,000	6

Table I-1 (cont'd)

II. WASTE CHARACTERISTICS

A-1 Hazardous Waste Quantity

- S = Small quantity (<5 tons or 20 drums of liquid)
- M = Moderate quantity (5 to 20 tons or 21 to 65 drums of liquid)
- L = Large quantity (>20 tons or 65 drums of liquid)

A-2 Confidence Level of Information

C = Confirmed confidence level (minimum criteria below)

- Verbal reports from interviewer (at least 2) or written information from the records.

S = Suspected confidence level

- No verbal reports or conflicting verbal reports and no written information from the records.
- Logic based on a knowledge of the types and quantities of hazardous wastes generated at the base, and a history of past waste disposal practices indicate that these wastes were disposed of at a site.
- Knowledge of types and quantities of wastes generated by shops and other areas on base.
- Based on the above, a determination of the types and quantities of waste disposed of at the site.

A-3 Hazard Rating

<u>Hazard Category</u>	<u>Rating Scale Levels</u>		
	0	1	2
Toxicity	Sax's Level 0	Sax's Level 1	Sax's Level 2
Ignitability	Flash point greater than 200°F	Flash point at 140°F to 200°F	Flash point at 80°F to 140°F
Radioactivity	At or below background levels	1 to 3 times background levels	3 to 5 times background levels
			Over 5 times background levels

- Use the highest individual rating based on toxicity, ignitability and radioactivity and determine the hazard rating.

<u>Hazard Rating</u>	<u>Points</u>
High (H)	3
Medium (M)	2
Low (L)	1

Table I-1 (cont'd)

II. WASTE CHARACTERISTICS (Continued)

Waste Characteristics Matrix

Point Rating	Hazardous Waste Quantity	Confidence Level of Information	Hazard Rating
100	L	C	H
80	L	C	H
	M	C	H
70	L	S	H
60	S	C	H
	M	C	H
50	L	S	H
	L	C	L
	M	S	H
	S	C	H
40	S	B	H
	M	S	H
	M	C	L
	L	S	L
30	S	C	L
	M	S	L
	S	S	H
20	S	S	L

Notes:
 For a site with more than one hazardous waste, the waste quantities may be added using the following rules:
Confidence Level

- Confirmed confidence levels (C) can be added
- Suspected confidence levels (S) can be added
- Confirmed confidence levels cannot be added with suspected confidence levels

Waste Hazard Rating

- Wastes with the same hazard rating can be added
- Wastes with different hazard ratings can only be added in a downgrade mode, e.g., HCM + SCH = SCH if the total quantity is greater than 20 tons.

Example: Several wastes may be present at a site, each having an HCM designation (60 points). By adding the quantities of each waste, the designation may change to LCM (80 points). In this case, the correct point rating for the waste is 80.

B. Persistence Multiplier for Point Rating

Persistence Criteria	Multiply Point Rating From Part A by the Following
Metals, polycyclic compounds, and halogenated hydrocarbons substituted and other ring compounds	1.0
Straight chain hydrocarbons	0.9
Easily biodegradable compounds	0.8
	0.4

C. Physical State Multiplier

Physical State	Multiply Point Total From Parts A and B by the Following
Liquid	1.0
Gel-like	0.75
Solid	0.50

Table I-1 (cont'd)

III. PATHWAYS CATEGORY

A. Evidence of Contamination

Direct evidence is obtained from laboratory analyses of hazardous contaminants present above natural background levels in surface water, ground water, or air. Evidence should confirm that the source of contamination is the site being evaluated.

Indirect evidence might be from visual observation (i.e., leachate), vegetation stress, sludge deposits, presence of taste and odors in drinking water, or reported discharges that cannot be directly confirmed as resulting from the site, but the site is greatly suspected of being a source of contamination.

B-1 POTENTIAL FOR SURFACE WATER CONTAMINATION

Rating Factor	Rating Scale Levels			Multiplier
	0	1	2	
Distance to nearest surface water greater than 1 mile (includes drainage ditches and storm sewers)	2,001 feet to 1 mile	501 feet to 2,000 feet	0 to 500 feet	8
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.
Surface erosion	None	Slight	Moderate	Severe
Surface permeability	0.8 to 1.5 ¹ cm/sec (> 10 ⁻² cm/sec)	1.5 ¹ to 30 ¹ clay (10 ⁻² to 10 cm/sec)	30 ¹ to 50 ¹ clay (10 ⁻² to 10 cm/sec)	Greater than 50 ¹ clay (< 10 cm/sec)
Rainfall intensity based on 1 year 24-hr rainfall	< 1.0 inch	1.0-2.0 inches	2.1-3.0 inches	> 3.0 inches
B-2 POTENTIAL FOR FLOODING				
Floodplain	Beyond 100-year floodplain	In 25-year flood- plain	In 10-year flood- plain	Floods annually
B-3 POTENTIAL FOR GROUND-WATER CONTAMINATION				
Depth to ground water	Greater than 500 ft	50 to 500 feet	11 to 50 feet	0 to 10 feet
Net precipitation	Less than -10 in.	-10 to +5 in.	+5 to +20 in.	Greater than +20 in.
Soil permeability	Greater than 50 ¹ clay (> 10 ⁻² cm/sec)	30 ¹ to 50 ¹ clay (10 ⁻² to 10 cm/sec)	1.5 ¹ to 30 ¹ clay (10 ⁻² to 10 cm/sec)	0.8 to 1.5 ¹ clay (< 10 ⁻² cm/sec)
Subsurface flow	Bottom of site greater than 5 feet above high ground-water level	Bottom of site occasionally submerged	Bottom of site frequently sub- merged	Bottom of site lo- cated below mean ground-water level
Direct access to ground water (through faults, fractures, faulty well casings, subsidence fissures, etc.)	No evidence of risk	Low risk	Moderate risk	High risk

Table I-1 (cont'd)

IV. WASTE MANAGEMENT PRACTICES CATEGORY

A. This category adjusts the total risk as determined from the receptors, pathways, and waste characteristics categories for waste management practices and engineering controls designed to reduce this risk. The total risk is determined by first averaging the receptors, pathways, and waste characteristics subscores.

B. WASTE MANAGEMENT PRACTICES FACTOR

The following multipliers are then applied to the total risk points (from A):

Waste Management Practice	Multipier
No Containment	1.0
Limited containment	0.95
Fully contained and in full compliance	0.10

Guidelines for fully contained:

Landfills:

- Clay cap or other impermeable cover
- Leachate collection system
- Liners in good condition
- Adequate monitoring wells

Surface Impoundments:

- Liners in good condition
- Sound dikes and adequate freeboard
- Adequate monitoring wells

Spills:

- Quick spill cleanup action taken
- Contaminated soil removed
- Soil and/or water samples confirm total cleanup of the spill
- Concrete surface and berms
- Oil/water separator for pretreatment of runoff
- Effluent from oil/water separator to treatment plant

General Note: If data are not available or known to be complete the factor ratings under items I-A through I, III-B-1 or III-B-3, then leave blank for calculation of factor score and maximum possible score.